

M. Planck
ACCOUNT *From the Author*
OF
OBSERVATIONS *9*

MADE WITH
A TWENTY-FEET REFLECTING TELESCOPE:

COMPREHENDING,

1. DESCRIPTIONS AND APPROXIMATE PLACES OF 321 NEW DOUBLE AND TRIPLE STARS.
2. OBSERVATIONS OF THE SECOND COMET OF 1825.
3. AN ACCOUNT OF THE ACTUAL STATE OF THE GREAT NEBULA IN ORION, COMPARED WITH THOSE OF FORMER ASTRONOMERS.
4. OBSERVATIONS OF THE NEBULA IN THE GIRDLE OF ANDROMEDA.

By J. F. W. HERSCHEL, Esq. M.A.

Fellow of St. John's College, Cambridge,

F.R.S. L. & E. M.R.I.A. F.G.S. M.A.S. M.C.U.P.S.

Member of the Royal Academies of Göttingen, Copenhagen and Naples, the Helvetic Society, the Italian Society of Modena, Acad. dei Lincei at Rome, and Gioenian Acad. of Catania; Assoc. ex intim. Acad. Dijon, Corresp. Philomath. Soc. Paris; Honorary Member of the Society for promoting useful Arts in Scotland, &c.

[From the Memoirs of the Astronomical Society of London.] 1837

LONDON:
PRINTED BY RICHARD TAYLOR, SHOE-LANE.
1826.



THE
LIBRARY OF
THE
MUSEUM OF
COMPARATIVE ZOOLOGY
AT HARVARD UNIVERSITY
CAMBRIDGE, MASS.

XXIX. *Account of some Observations made with a 20-feet Reflecting Telescope : comprehending,*

1. *Descriptions and approximate Places of 321 new Double and Triple Stars.*
2. *Observations of the second Comet of 1825.*
3. *An Account of the actual State of the Great Nebula in Orion, compared with those of former Astronomers.*
4. *Observations of the Nebula in the Girdle of Andromeda.*

By J. F. W. HERSCHEL, Esq. For. Sec. Ast. Soc.

Read April 14, May 12, and June 9, 1826.

THE telescope with which the following observations were made, is one of that construction which has been called the front-view. The aperture or clear polished surface of its mirror is 18 inches, and its focal length 20 feet. It was constructed in the year 1820, under the joint superintendence of my father and myself, on the model of that used by him in his "Sweeps of the Heavens," whose place it was intended to supply, the wood-work of the latter being greatly decayed by age. It was therefore dismounted, and the less perishable part of its materials employed in the construction of its successor. At the same time a new speculum was cast, with a view to preserve the old one, the figure of which is particularly fine, for the most delicate observations. This is the speculum employed in the observations I am about to detail. The manual work of grinding and polishing it was executed by myself; and though certainly capable of considerable improvement in point of figure, such as at a convenient opportunity I propose to give it, yet on the whole I have no reason to regret the time and trouble bestowed on it. Its light with its full aperture is such as to reach with facility the faintest nebulae of the 3d class in my father's catalogues, and even to add to their number, while its distinctness with an aperture limited to 12 inches is sufficient for the definition of Double Stars of the first class of an average degree of closeness, and when turned on

objects of a sensible diameter, as the moon and planets, yields in distinctness to no telescope I have yet seen, showing with the reality of a tangible object, the most microscopic inequalities in the moon's surface, the planetary discs of Jupiter's satellites, and all the delicacies of Saturn's ring, belts, &c., which are usually chosen as tests of the performance of telescopes, provided the atmosphere be favourable, and the magnifying power be not carried beyond 300. When the whole aperture is used, a lower power becomes necessary to keep down the aberration, and that which I generally employ, as a sweeping power, is about 150 or 160, being produced by a single lens of an inch and a half focus. With this arrangement its great light gives it a kind of supremacy over the ordinary achromatics and 7- and 10-foot Newtonian reflectors, nor can anything be more striking than the comparison of the appearances of such an object as the nebula in Orion, or one of the more remarkable of the globular clusters, such as No. 15 *Messier*, when viewed alternately in this and the instruments last named.

Curiosity, however, is soon satisfied with the view of such standard and prominent objects, beautiful as they are, and the possessor of such an instrument is naturally excited to pursue a regular systematic plan of examining the heavens more in detail for new and remarkable objects, and recording his discoveries. The method of differences pursued by my father in his Sweeps, is the only one by which, in the present state of their mechanism, such instruments can be rendered available. It is fully detailed in the preface to his first Catalogue of Nebulæ, published in the *Transactions of the Royal Society*, for 1786. I need only mention here, therefore, that it consists in giving by the aid of a labouring assistant, a constant and regular motion to the telescope in polar distance, to the extent of about 2° up and down, so that as the heavens are carried round by their diurnal motion, a zone of 2° in breadth passes under the observer's eye. The breadth of this is limited by two bells, which are made to strike by a proper mechanism at the top and bottom of the sweep, to warn the assistant to reverse the motion of the "Sweeping handle." The telescope is now all the while brought to a constant bearing by a rubbing bar against the east ladder of its frame-work, which is strengthened and rendered immoveable by lateral stays, instead of being, as formerly, brought by the intervention of a plate of iron to bear against a roller clamped to the ladder. The various objects which the sweep presents, have their places ascertained by arresting the sweeping motion, bringing the object to the horizontal diameter of the field, in polar distance, noting the moments by a sidereal clock, or chro-

nometer, when it passes the centre, and finally reading off the Polar distance by a quadrant, a Polar distance clock, or other convenient apparatus. It is obvious that by this method, only differences of Right Ascension and Polar distance can be obtained, on account of the unknown (but constant) errors of the instrument. But as care is always taken to include in the sweep a sufficient number of known stars, each of these becomes a zero point, for the determination of all the rest of the observed objects.

Such is the general nature of the process of sweeping in the meridian with telescopes of this description. As this is the best situation for observation, and as with such instruments there is always plenty of work to keep the most active observer in full occupation, whatever part of the heavens may happen to be passing, it is rarely adviseable to use them in other situations. When so used, the places of new objects cannot in general be ascertained with precision enough to identify them with certainty, and they degenerate from astronomical to mere star-gazing instruments. I speak now of the ordinary use of the telescope. Cases of course arise when this becomes necessary.

It will now be right to mention more particularly the modifications I have introduced into my father's system of sweeping,—modifications rendered necessary by the loss of my aunt, Miss CAROLINE HERSCHEL's personal assistance, on whom the task of reading and registering the Polar distances and Right Ascensions of objects, writing down the remarks and descriptions, warning the observer of expected stars, and finally reducing and calculating the whole, used invariably to devolve. Unsupported by such aid, I am under the necessity of recording the observations myself; an inconvenience of the worst kind, not only as it diminishes by at least one half, the number of objects that can be taken, but because the frequent admission of extraneous light into the eye is fatal to observations of the fainter nebulae. However, by a disposition of the apparatus adapted to the change of circumstances, I have succeeded tolerably well in bringing the whole process within reach, without the necessity of a change of place, and even in getting rid of some sources of inaccuracy, which were unavoidable in the former system. The chief alterations I have made are as follows.

1st. Instead of conducting the motion of the telescope in Polar distance by a line over pulleys to a piece of clock-work at a distance, the motion of whose hands should indicate the change of its inclination to the horizon, a graduated sector is now attached to the eastern side of the tube, near its mouth. The arc it comprises is rather more than 3° , and is divided into degrees and mi-

minutes, commencing from zero at its lower limit. The great length of its radius (nearly 20 feet) produces a corresponding extension of the divisions; each degree being represented by $4^{\text{in}}.2$; each minute by $0^{\text{in}}.07$, and even a single second, being measured by $0^{\text{in}}.0011$, is a quantity perceptible with the naked eye. It is read off by a microscope and index attached to a stout wooden frame, which is firmly clamped by strong screws across the eastern ladder during the continuance of each night's sweep, so as to be perfectly free from shake, and moveable only by a general displacement of the whole ladder, which from the security afforded by the lateral stays and the general strength of the framework of the instrument, is very small, and can only take place, if it take place at all, nearly in the direction of the radius, so as scarcely to affect the readings. This frame (or Polar distance piece, as I term it) when unclamped, is moveable to any part of the ladder, so as to adjust the zero point marked by its index to any required polar distance, which is always that of the top of the sweep, and is determined approximately by a BIRD'S quadrant of 12 inches radius, fixed to the side of the tube at its lower part*.

The effect of this arrangement is a very material improvement in the accuracy of all the determinations of Polar distance afforded by the instrument. On the former plan, an error in Polar distance to the extent of 3 or 4 minutes might easily be committed, and occasional errors even to a more considerable amount could not be certainly avoided, from the unequal tension and hygro-metrical alterations of so long a line as was necessary to communicate the motion of the telescope to the clock within-doors. The present arrangement renders an error in the Polar distance of any object sufficiently well defined, to the extent of a whole minute, (as determined by a single observation,) very unlikely; and I am inclined to believe that in tolerably still weather, the Polar distances observed in the ordinary course of sweeping will seldom differ half a minute from the truth. I ground this opinion on the following list of the

* In Mr. RAMAGE's description of his 25-feet reflecting telescope, a similar apparatus for Polar Distances is described (page 417 of this volume) as attached to the *gallery* of the telescope. The idea was probably suggested by witnessing the performance of the instrument at Slough,—but other, and very material changes must be made in Mr. R.'s construction, before it can be used with confidence as a sweeping telescope. The attachment of the Polar Distance piece to the *gallery* rather than to the ladder, would alone be fatal to the accuracy of observations in Polar Distance. I presume, however, that the passage in Mr. R.'s paper alluded to, is to be understood as pointing out what might be the construction and use of the parts in question, rather than what actually is in any one hitherto constructed by him.

discordances found to exist between the reduced Polar distances of such nebulae and Double-stars as I have accidentally taken in sweeps made on different nights since I commenced this course of observation. It comprises *all* the cases which have occurred, where the objects have been tolerably definite and observed on the horizontal wire of the eye-piece, and a great portion of them are derived from sweeps made in very windy weather.

By Nebulae.		By Double-Stars.	
0'	8"	1'	8"
0	33	0	35
0	36	0	12
0	49	0	4
0	23	0	25
0	4	0	18
0	18	0	4
0	12	0	2 (a)
0	13	2	42 (b)
0	46	0	12
0	37	0	12
2	48	0	33
		0	8
		0	52

The differences marked (a) and (b) occur in the case of objects of doubtful identity, especially the latter. Rejecting these, the average of the whole is 0' 34", and this being the difference of the observed extremes, the probable average error of each single observation is the half of this, or 17". This may seem a large quantity to those who are accustomed to the delicacies of fixed instruments; but it will be recollected that the only objects aimed at in the determination of the places of bodies in sweeping with this instrument, are their complete identification, and the power of finding them again with certainty in future; and moreover, that so far from regarding this as a fair specimen of the results, the observations I have hitherto made can only be considered as a rude trial, destined to satisfy myself of the practicability of observing without assistance other than that of a labourer, and that there is hardly a part of the apparatus devoted to this purpose in which the most essential improvements do not remain to be made.

The next alteration I have been obliged to make is for the worse, and is in the mode of marking the time, which instead of being referred to the sidereal clock directly, is noted by a portable 6-hour clock placed in the gallery by

the observer's side. The inconvenience and error introduced by this arrangement, are, however, so great as to oblige me to resolve on discontinuing it in future, and observing the transits by a chronometer. Most of the errors, it is true, have originated in the clock itself used, which is one of the commonest construction, and uncompensated,—so that I find, on examining the sweeps I have made up to the present time in all weathers, an average probable error of nearly 3" of time, and a discordance between the results of individual observations attaining occasionally, though rarely, five times that amount.

The eye-piece I ordinarily use for sweeping, differs from that employed by my father. It is furnished with a horizontal and two vertical wires, and a slider so adjusted as to have one of the vertical wires bisecting the field at the eastern and the other at the western limit of its motion, so that an object may be followed, if requiring inspection, from one field to another, and its transit, if missed on the first wire, taken on the second. The mistakes this arrangement is apt to cause, can only be prevented by a regular system of re-examining and replacing the slider after every observation. I hope that instances of them in the observations to be recorded hereafter, are few,—but will not undertake to say that none exist. The illumination of the field is easily performed. The fainter nebulae of the 3d class, however, will not admit of any being used; but the general light of the sky and the small stars in and near the field of view, for the most part afford sufficient sight of the wires to obtain their transits. If not, they must be taken as near as may be in the centre of the field. Those of the 1st and 2d classes, and stars down to the 15th magnitude, will bear a sufficient illumination to admit of their bisection, or covering by the wire. It may here be inquired, what idea I attach to the magnitudes of the stars, as observed with this instrument. The scale of course is arbitrary, and will not apply to telescopes of inferior light; but having by habit obtained a pretty constant impression of the appearance of stars set down as of the 6th magnitude in the catalogues (which may be about equal to those of the 1—2 m. in an achromatic of $3\frac{3}{4}$ inches), the scale is prolonged downwards, as follows.

7 m.—A very bright and distinguished star.

8 m.—Bright; announces itself before entering the field by a pretty strong gleam, catches the eye, and is always noticed in sweeping as a remarkable star.

Example. The satellites of Jupiter.

- 9 m.—Enters the field often unexpectedly ; but is conspicuous in the strongest illumination.—A pretty frequent star. Those of 8 m. (except in particular regions) are rare.
- 10 m.—Bears any moderate degree of illumination, and is easily observed on the wires with a strong light.—A good star for settling the places of nebulae and faint double-stars.
- Example.* The large satellite of Saturn.
- 11 m.—Very common : often seen in great numbers at once. Large tracts of the Milky Way are full of them, as are many clusters. Is easily observed with a well illuminated field.—A star of average brightness in sweeping.
- Example.* The second (in order of brightness) of Saturn's satellites.
- 12 m.—Rather faint, but bears illumination pretty well.—Is never to be overlooked in any part of the field.
- Example.* The small star of α Lyrae. The third and fourth (in order of brightness) of Saturn's satellites.
- 13 m.—Faint. May be observed in an illuminated field, but the illumination must be used with care.—Is not conspicuous, but catches the eye as an appendage to another star not very bright.
- Example.* The faintest of the five old satellites of Saturn.
- 14 m.—Very faint. Cannot be observed with illumination, alone, unless by very cautious management of the light ; but when the eye is guided by a star close to it, its position and distance may be determined pretty well in a feeble light.
- 15 m.—Hardly to be seen with light in the field even when close to another star. In the dark field attracts no notice, except when numerous, or near others.—May very well be overlooked.
- 16 m.—Extremely faint. Three or four of them together make a nebulous appearance, which requires the sweeping motion to be arrested to distinguish the individuals. When near another star, is obliterated when the eye is directed full upon it, but comes out and is noticed when the eye is turned a little aside.
- 17, 18, 19, 20.—*Intensiva* of faintness down to the *minimum visible*, which can only be caught by long attention, in favourable glimpses. None of them can be seen with the least illumination.—The stars seen or suspected in resolvable nebulae, if separate, might belong to the last of these classes.

As an example of the manner in which the business of "a sweep" is conducted, and of the method of obtaining from it the approximate Right Ascensions and Polar distances of the objects it comprises, I have here extracted verbatim from my observing-book the whole of a sweep made on the 17th October last year, with the subsequent reductions.

Col.

1. Contains the number of the object in the sweeps for reference.
2. The time of its transit, as observed by the portable clock.
3. The wire on which it was taken. The letter M in this column opposite line 5, denotes that the object being too faint for observation with an illuminated field, was taken in the middle of the field by estimation.
4. The reading of the index arc, or graduated sector at the end of the tube, which gives the differences of Polar distance.
5. The initial of the general designation of the object, to facilitate indexing the observations. N nebula, D double-star, S settling star, or a star proper to be used for determining the reductions of columns 2 and 4, Cl cluster, &c.
6. In this column are inserted diagrams of double-stars, and representations of nebulae, &c. made at the time, and afterwards; in the blank spaces, the names, &c. of identified stars and nebulae. The diagrams here are omitted. In the names, &c. the Roman and Italic numbers affixed to the nebulae denote my father's classes and numbers.
7. Contains an abbreviated description of the object. The abbreviations used are the same as those used by my father in his catalogues of nebulae.
8. Contains the reductions in Right Ascension and North Polar distance, as deduced from each of the settling stars, by bringing up its mean place to the beginning of the year, and subtracting from its Right Ascension and Polar distance the observed quantity in columns 2 and 4; and the final reductions thence derived to be applied to all the other objects.
9. Contains the Right Ascensions deduced afterwards by the application of the reductions of column 8 to the numbers in column 2.
10. The North Polar distance similarly deduced from column 4, by applying the reduction in North Polar distance, column 8.

SWEET, Oct. 17, 1825.

No.	Monkey Clock.	Wire.	Index Arc.	Obj.	Diagram, Name, &c.	Description, Remarks, &c.	Reductions.	R 1825-0.	N. P. D. 1825-0	No.
1	h m s					Monkey set with transit. Began sweep. An indifferent observation.	By m. s. 2 -0 51.4			1
2	21 49 38.5	2	+1° 4' 10"	S	- - - -		6 -0 52.5	22 16' 45.4	86° 12' 53"	2
3	22 13 43.0	1	+0 59 40	S	d Pegasi		37 -0 57.8	22 25 3.2	78 24 13	3
4	18 1.5	2	2 32 0	D	- - - -	35° nf 30° 9 and 11 or 8 and 10 m.	41 -0 57.4	22 28 47.1	80 21 53	4
5	25 55.0	1	0 43 20	D	- - - -	87° sp 30° 10 and 10½ m.				5
6	29 39.0	M	2 41 0	N	Not in M.S. Cat.	Extremely faint. Elongated perpend. to merid.				6
7	33 36.0	1	2 23 40	S	ζ Pegasi					7
8	37 22.0	2	1 36 10	D	- - - -	50 sp 20°, 11 and 12 m.	The rate of the clock is evidently accelerating, and the gain is 1" in 36", so that we have Mean Reduction in R for 1st wire	22 36 5.4	79 17 3	8
9	42 2.0	1	1 37 40	N	III. 216	R. F. g δ M. a star precedes.	= -0" 51.5 clock—22h 14m 36m 1"	22 41 9.7	79 18 33	9
10	45 52.5	2	2 23 40	D	- - - -	60° np, 9 and 12 m., 4 or 5".		22 44 35.7	80 4 33	10
11	50 30.0	2	0 8 0	N	III. 465	Extr. F. R. δ M.		22 49 13.0	77 48 53	11
12	23 4 15.0	2	0 20 0	N	Not in M.S. Cat.	Extr. F. R. Seems to have a star in centre.		23 2 57.7	78 0 53	12*
13	7 56.0	2	0 5 0	N	III. 222	Windy.				13*
14	19 18.0	1	+0 49 20	N	III. 226	R. sm δ M. p. B. Small, has a B. st. near. A neb. in field with the last, and preceding it about 5' of time. R. F. half a minute in diam.		23 6 38.8	77 45 53	14
15	24 48.0	2	48 20	D	- - - -	R. p L. R. g δ M. almost to a star.		23 6 33.2	77 38 23	15
16	27 48.0	2	0 8 0	D	- - - -	0° f, 10°, 10 and 11 m.				16
17	36 14.0	1	2 30 50	N	II. 255	R. B. a B star foll.	Reduction from 2d to 1st wire = -0" 24.5	23 18 24.7	78 30 13	17
18	54 9.±	1	0 18 ±	N	- - - -	Looked for the "Suspected Nebula" of M.S. Catal. It is verified. It is however, so nearly a star in appearance, as to be easily mistaken for the 34 star of a trapezium (triangle i) The place is here put down as in the working list, but it was found in the middle of the field by it.		23 26 30.0	78 29 13	18
19	0 9 14.5	2	0 45 10	D	- - - -	65° sf, 15°, 9 and 10 m.	Reduction in N. P. D. By 2 +77 41' 0" 6 +77 40 59 37 +77 41 10 41 +77 40 23 Mean +77 40 53	23 35 20.2	80 11 43	19
20	14 40.±	2	2 48 30	N	II. 257	F. p L. R. g δ M.		0 7 55.6	78 26 3	20
21	27 43.0	2	0 4 20	S	- - - -	7 m.		0 13 20.7	80 29 23	21
22	34 48	2	2 32 40	D	- - - -	20° np 25° 10 and 11 m.		0 33 28.2	80 13 33	22
23	37 19	1	0 45 40	D	- - - -	45° sf 10°, 9 and 10 m.		0 36 23.5	78 26 33	23
24	40 50	2	0 34 40	D	- - - -	40 nf, 5 or 6°, 12 and 13 m. a 3d sp.		0 39 29.8	78 15 33	24
25	45 34	2	1 17 45	D	- - - -	10 sf 12 or 15° 9 and 9½ m. nearly equal		0 44 13.8	78 58 38	25
26	48 5	1	1 11 20	Cl	- - - -	A small cluster of pretty close stars.		0 47 9.2	78 52 13	26
27	57 16	2	0 25 50	Tr	- - - -	Calm and Clear.				27
28	1 3 19	2	0 24 30	D	- - - -	A very elegant triple star, 1 and 2 40° np, 3; 1 and 3 40° nf 7 or 8". 1=8 m, 2=10 m, 3=9 m.		0 55 55.5	78 6 43	28
29	5 59	1	0 19 20	D	- - - -	3° np, 5°, 11 and 12 m.		1 1 58.3	78 5 23	29
30	16 3	2	0 20 0	N	II. 252	45° sp 10°, 10 and 11 m.		1 5 2.7	78 0 23	30
31	16 15	2	0 20 0	D	- - - -	Irr. R. v L. rg a little δ M. has a neat D. st. foll.		1 14 42.0	78 0 53	31
32	21 53	1	0 35 20	D	- - - -	40° np, 10 or 12°, 8 and 13 m. immediately following the nebula II. 252.		1 14 54.0	78 0 53	32
33	25 19	2	1 11 20	D	- - - -	5° np 8 or 9°, 9 and 10 m. very neat.		1 20 56.3	78 16 13	33
34	28 34	1	1 24 0	D	- - - -	30° nf, 12°, 10 and 13 m.		1 23 57.7	78 52 13	34
35	31 11	2	1 1 0	D	- - - -	60° sf or np, 20-25°, equal, 10 and 10 m.		1 27 37.1	79 4 53	35
36	35 25	1	1 5 50	D	- - - -	5° np, 5-7°. 9 and 10 m. neat.		1 29 49.5	78 41 53	36
37	38 51	1	2 20 50	S	Pleiades 300 Bode.	50° sp, 20-25°, 9 and 10 m.		1 34 27.8	78 46 43	37
38	40 45±	1	1 30 0	N	Not in M.S. Catal.	7 m or 67 (marked 8 m in Bode).				38
39	45 3	1	0 30 10	S	- - - -	Extremely F. taken at 41" 45' about 1" after the transit, which was missed.		1 40 ±	79 10 45	39
40	47 29	1	1 24 10	D	- - - -	6 or 7 m.				40
41	51 0	1	0 53 0	S	Arietis 26 Bode.	85° np 20° 12 and 13 m. Index taken at 49".		1 46 31.6	79 4 44	41
42	54 14	1	0 36 50	D	- - - -	v B. 5 m. (N.B. marked 8 m. in Bode).				42
43	58 20	1	2 40 30	D	- - - -	75° nf, 25°, 10 and 11 m.		1 53 16.4	78 17 43	43
44	2 6 55	1	1 4 0	D	- - - -	45° np, 30°, 8 and 15 m.		1 57 22.3	80 21 23	44
45	11 7	1	4 30	Q	- - - -	10° sf, 7 or 8°, 10 and 11 m.		2 5 57.0	78 44 53	45
						Quadrant read off 40° 8' 40". Transit clock 2h 11m 0". Monkey fast on transit +7".				

* No. 12.—Its place agrees exactly, if supposed to have been really taken on the 1st wire, instead of the 2d as marked in the observation, and in that case its R for 1825 = 23 7 3.
 † No. 38.—R extremely uncertain. May be 30° or 40° or a minute wrong.

As a further example of the degree of coincidence which may in favourable circumstances be expected, I annex the results of the reduction of the several settling stars taken in a Sweep made the 3d of April, 1826, with a chronometer in place of the journeyman clock, by way of trial.

Reductions in Right Ascension.

By δ Cancr.	— 0	11 ^m	29,0
By ψ Leonis	— 0	11	29,6
By θ Leonis	— 0	11	28,8
By δ Leonis	— 0	11	29,0
By δ Leonis	— 0	11	27,9
By β Leonis	— 0	11	28,9
By γ Comæ	— 0	11	31,9
By γ Virginis	— 0	11	30,7
By γ Virginis	— 0	11	31,1
By Bootis 247	— 0	11	36,5::
By ζ Bootis	— 0	11	33,3
By β Serpentis	— 0	11	34,6

The apparent deviation of the chronometer from its rate at the end of the Sweep, is the effect of the cessation of a violent west wind, relieving the east ladders from the pressure of the end of the tube.

Reductions in Polar Distance.

By δ Cancr.	+ 73°	31'	27"
By ψ Leonis	+ 73	31	57
By η Leonis (out of the sweep) ..	+ 73	31	31
By θ Leonis	+ 73	31	28
By δ Leonis	+ 73	31	51
By δ Leonis	+ 73	31	57
By β Leonis	+ 73	31	11
By γ Comæ	+ 73	31	54
By γ Virginis	+ 73	31	48
By 247 Bootis	+ 73	31	50
By ζ Bootis	+ 73	31	20
By β Serpentis	+ 73	31	16
Mean	+ 73	31	37

It is clear then, that the observations of Polar distance are susceptible of considerable exactness, the greatest deviation from the mean in all these, being only 26" during a sweep of seven hours duration.

The reductions ought in strictness to be performed as follows :—Every star observed in the course of the sweep which can be identified with a star in any catalogue, and whose place is determined with certainty, is taken as a zero point. Its Right Ascension and Polar Distance being computed for the time of observation, the readings of the clock and index are respectively subtracted, from them the former being (if necessary) reduced to the first wire ; and the remainders are set down in the column of *Reductions*, with the number of the object from which they are obtained. It is clear that were all the observations perfect, the clock going exact sidereal time, and the instrument in exact adjustment, these *reductions*, added to all the other numbers in the columns of the clock and index arc, must give the true right ascensions and polar distances of all the other objects observed in the sweep ; and that the same reductions ought to result from each of the settling stars. But this will never be found to be exactly the case. The differences of the reductions in right ascension will indicate the rate of the clock, and must be taken account of. Thus it appears in the foregoing sweep that the clock was gaining 1^s in every 36^m on the stars, which is allowed for by annexing to the constant mean reduction $-0^m 51^s.5$ the term $-\frac{\text{clock} - 22^h 14^m}{36^m} \times 1^s$. The near agreement of

the reductions in North Polar distance, is a proof of the general steadiness of the telescope, and the mean of them all $+77^\circ 40' 53''$ may very safely be used as a common or constant reduction to be applied with its proper sign to all the readings of the index arc, to give the Polar distances of the unknown objects.

Thus are the apparent Right Ascensions and Polar distances at the moment of observation strictly obtained ; and by applying the usual corrections for precession, aberration and nutation, may be reduced to the beginning of the year, or any epoch. For the purpose, however, of merely identifying the objects, this is not called for, and in the above instance is not done. The places of the stars are merely brought up to the beginning of the year of observation. The errors which this produces in Right Ascension are insensible, and in Polar distance can amount very rarely to $10''$; and the effects of aberration, nutation and difference of refraction within the limits of the sweep may be in like manner neglected, when the object is only to form an approximate catalogue, true to the nearest minute in Polar distance, and the nearest decimal of a minute of time in Right Ascension.

Such a degree of approximation is all that has been attempted (and perhaps not always obtained) in the following catalogue. It contains the places and

general descriptions of such double-stars as have occurred in the various sweeps I have had occasion to make up to the present time, when they could be taken without interfering with the principal object in view in making them, which is a general review of the nebulae discovered by my father, and an examination of the actual state of the nebulous heavens,—a task of great extent and slow progress, and of which I will take this opportunity to observe, that so far as I have gone in it, I find no difficulty in recovering and identifying the objects described by him in his several catalogues of nebulae published in the *Philosophical Transactions*, and even of adding considerably to their number, being most effectively aided in the undertaking by the indefatigable zeal and energy of my aunt, already mentioned, who during her residence in her native city has completed the immense work of revising and re-reducing the whole mass of his 20-feet sweeps, and arranging the nebulae and principal stars observed in them in two general catalogues in zones, in the order of Right Ascension. Without this assistance, I question whether I should ever have had the courage to venture on the task of re-examination. At its commencement I had no reason to hope for co-operation from other quarters, as instruments adequate to such observations were of the utmost rarity, and indeed not to be procured at all. The case is now, happily for astronomy, somewhat changed. Refracting telescopes of extraordinary dimensions have been constructed, and are constructing, by artists both in Munich, in Paris, and in London. I have no doubt that the nebulae at least of the first and second classes will prove to be within their reach, and there is every reason to hope that the *chef-d'œuvres* of AMICI, and large reflectors such as that recently submitted to the inspection of this society by Mr. RAMAGE, will contribute greatly to place this interesting department of astronomy within the power of any one who may be fortunate enough to possess them. I hope indeed that the use of large reflectors will not long remain confined, as it has hitherto been, to a few. Much has been done with them already, but what remains to be explored is truly immense; and the wonders which the minute examination of the heavens presents, are so far from exhausted, that, bold as the expression may appear, I believe it may be truly said, sidereal astronomy is yet in its infancy.

But to return to our Double-stars.—The catalogue which follows is merely, as I have already said, so far approximate as to enable any astronomer to set an instrument directly upon the objects it contains, without fear of mistake. Each star is accompanied with a brief description and estimated values of its angle of position and distance, and the magnitudes of the stars of which the

double-star consists. Such estimations are of course liable to much error in particular cases; yet in general, the errors can hardly be so enormous but that, if sensible motions exist in them, a re-examination made at a sufficient distance of time will not detect them. But an idea of their probable extent and frequency of occurrence will be most correctly formed from the following instances (being all which have hitherto occurred to me), in which double-stars taken and regularly estimated in the course of sweeping have since been identified and recognized as known. These estimations compared with Mr. SOUTH's and my own measures, are here set down side by side.

Star.	R. A.	Estimated Position and Distance.	Measured Position and Distance.
δ Orionis	5 ^h 23 ^m	Nearly 90° n 80' wind furious.	89° 57' nf, 55" H. and S.
σ Orionis 1, 2	5 30	0° f, 12...15" } Wind	{ 6 41 nf 13 } H. and S.
— 1, 3		20 nf, 60" } furious.	
11 Monocerotis	6 20	1 and 2 not noticed as divided. (1.2) and 3, 45° np 12"	About 41°, 8" to the bisection of the close stars.
29 Monocerotis	8 0	1 and 2, 20° sf, 20...30" 1 and 3, 25 sp, 60"	27° 1' sp, 66" H. and S.
18 BODE Hydrae	8 26	65° nf, 12...15"	67 57 nf, 11 H. and S.
IV. 54 —	8 31	65 nf, 7...8	59 47 nf, 20 S.
IV. 111 —	8 40	35 sf, 20	34 16 sf, 17, H. and S.
τ —	9 20	85 nf, 60...70	86 49 nf, 67, H. and S.
6 h Leonis	9 22	15 nf, 35...40	15 27 nf, 38, S.
7 —	9 26	15 nf, 40	9 25 nf, 44, H. and S.
155 BODE —	10 14	60 np, 70	60 23 np, 60, H. and S.
383 STRUVE	11 10	25 sp, 12...15	18 1 sp, 10, S.
88 Leonis	11 23	45 np, 25	50 14 np, 15, H. and S.
427 STRUVE	12 47	60 sp, 15	73 43 sp, 29, S.
θ Virginis	13 1	60 np, 7...8 (1 and 2) 30 np, 60 (1 and 3)	77 8 np, 8, H. and S. 24 3 np, —
481 STRUVE	15 10	75 sf, 20	84 20 sf, 13, H. and S.
β Serpentis	15 38	0 p, 25	3 or 4° sp, 24, Sir W. H.
680 STRUVE	20 23	35 sp, 15...20	14 22 sp, 15, H. and S.
685 STRUVE	20 27	82 sp, 15	73 49 sp, 10, S.

Of the twenty-one estimated angles here stated, thirteen do not differ 6° from the measured ones; while no less than eighteen, or six out of seven, are within 10° of the truth; and three (probably made in haste) differ as much as 13, 17, and 21° , and in the case of the last the identity of the star is otherwise very doubtful. There is an evident tendency to over-estimate the distances;—the sum of the estimated distances, (taking means where two limiting distances are stated,) being 617", and that of the measured ones only 566", being nearly in the ratio of eleven to ten, and the number of instances where the estimate exceeds the measure being double of those in which it falls short.—This should be borne in mind in perusing the annexed catalogue.

It may perhaps be inquired why we should aim at increasing our list of double-stars already so numerous, and why this list should be carried down to such minute objects as many of those here pointed out. To such a question I apprehend the answer may be found in this consideration: the labour of the astronomer in the present state of his science is much like that of one who should examine, grain by grain, the sands of the sea, in the certainty that among them numerous grains must exist of extraordinary value, or singular properties, and in that well-grounded hope of finding them, which a certain considerable amount of success already obtained would afford. The more individuals our search embraces of a class which has already proved productive, the greater our chance of further success; and so long as no presumption *à priori* can be adduced why the most minute star in the heavens should not give us that very information respecting parallax, proper motion, and an infinity of other interesting points, which we are in search of, and yet may never obtain from its brighter rivals, the minuteness of an object is no reason for neglecting its examination. The small star near μ Bootis—a most insignificant object,—is a revolving Double-star, a binary system; an object therefore of curious speculation. 61 Cygni, μ Cassiopeæ, ξ Ursæ majoris,—all trifling stars,—have claims on the watchful attention of astronomers, beyond many stars of the 1st magnitude. And who can say that among the innumerable multitudes of minute telescopic stars, some one or two may not be found near enough to our system to exhibit not only sensible, but large parallactic motions, or proper motions of a character approaching to planetary, and which may one day enable us to trace the existence of solar attraction beyond the limits of the orbits of the planets and comets of our present system, or to define the path of the sun in space? It is clear that if such cases exist, they will be most probably detected when a star in this predicament is in the immediate vicinity of

another not so circumstanced. But if small double-stars are to be watched, it is first necessary that they should be known; nor need we fear that the list will become overwhelming. It will be curtailed at one end, by the rejection of uninteresting and uninstrusive objects, at least as fast as it is increased on the other by the accession of new candidates for examination;—and if in the result, but one individual of such a nature as above hinted at should at length be found, the toils of whole generations of astronomers would be amply repaid;—it would be the diamond remaining after searching and throwing away the rubbish.

In the following list few double-stars of the first class will be found. The nature of the observations in which they were discovered, does not allow the motion of the telescope to be arrested, unless something peculiar in an object is discerned while in motion, sufficient to fix attention; and stars whose distance from each other is below one or two seconds, will of course pass unnoticed in this cursory way, and with the moderate power used. Had the object been expressly to make a catalogue of new double-stars, not only might a very much greater number have been presented, but many closer and many more delicate ones would have been included. Sufficient, however, will be found, to afford a judgement of the optical powers of the telescope. Thus in point of light I should be inclined to doubt whether the small stars of α^2 *Canceri*, ξ *Pegasi*, or 222 BODE *Canceri*, will be recognized with telescopes of less aperture. The former would have escaped my own observation, but was immediately noticed by Mr. RAMAGE, who, happening to be observing with me at Slough, pointed it out, since which I have again observed it double on a subsequent occasion.

A great many of the double-stars here set down, exhibit that singular and highly interesting phenomenon of contrasted colours. Thus those whose places are

R. A.	$0^h 1^m,0$	$10^h 31^m,3$	$12^h 6^m,1$	$15^h 21^m,3$	$19^h 22^m,0$	$21^h 41^m,8$
P. D.	$79\ 49\ ,0$	$77\ 2\ ,0$	$90\ 22\ ,0$	$78\ 56\ ,0$	$90\ 48\ ,0$	$78\ 30\ ,0$

R. A. $22^h 8^m,3$ $23^h 3^m,0$ $23^h 29^m,0$ } offer the combination of a white and a
P. D. $77\ 54\ ,0$ $76\ 28\ ,0$ $104\ 1\ ,0$ }

blue, or a purple star.—Cases of combinations in which yellow, orange, or red large stars are united with blue or purple small ones, occur in the instances

R. A.	$0^h 13^m,7$	$8^h 41^m,6$	$9^h 0^m,1$	$9^h 51^m,9$	$10^h 11^m,1$	$11^h 29^m,0$
P. D.	$77\ 30\ ,0$	$93\ 33\ ,0$	$90\ 50\ ,0$	$84\ 9\ ,0$	$77\ 46\ ,0$	$76\ 5\ ,0$

R. A. $11^h 40^m,9$ $11^h 56^m,6$ $22^h 5^m,9$ } Red and white combinations are
P. D. $93\ 52\ ,0$ $94\ 52\ ,0$ $73\ 42\ ,0$ }

rarer, but occur in the instances of

R. A.	$6^h 57^m,3$	$22^h 22^m,0$
P. D.	$95\ 56\ ,0$	$77\ 45\ ,0$

In all these cases, (and so far as I know, exceptions to this rule are very rare, though they do occur, as in the instance of α^2 *Canceri*, the excess of rays belonging to the less refrangible end of the spectrum falls to the share of the large star, and those of the more refrangible portion to the small. This may in some measure be accounted for by the fact that the more luminous rays are those of the least refrangible half; partly too by the effect of contrast. In many cases both the colours are too strongly marked to be merely illusion; and another fact not less remarkable, viz. that though red single stars are common enough, no example of an insulated blue, green, or purple one has yet been produced, renders the probability of some other relation than mere juxtaposition in such cases of decided contrast very considerable.

Approximate Places of 321 new Double and Triple Stars, for January 1, 1825, with their estimated Angles of position, Distances, Magnitudes, and other particulars.

Explanation.

Col.

1. Contains the general number.
2. The Right Ascension to the nearest decimal of a minute of time.
3. The North Polar Distance to the nearest minute. When the true Polar Distance falls about half way between two consecutive minutes, a + or a - is affixed, to indicate the fact; thus, $92^{\circ} 1'$ means that the Polar Distance is between $92^{\circ} 0'$ and $92^{\circ} 1'$ but nearer the 1 than the 0.
4. The estimated angle of position.
5. The quadrant in which the small star lies.
6. The estimated distance in seconds.
7. The estimated magnitudes.
8. Any remarks.—When Triple Stars occur, 1 is generally the largest of the close stars, 2 the nearest, and 3 the furthest.

No.	R.A. 1825 ⁰	N.P.D. 1825 ⁰	Angle.	Quadrant.	Distance.	Magnitudes.	Remarks.
1	^h 0 ^m 1,0	^o 79 49	^o 80	<i>sf</i>	7 or 8	6,11	S. blue and well defined, an elegant star.
2	0 7,9	78 26	65	<i>sf</i>	15	9,10	
3	0 8,9	77 55	10	<i>nf</i> or <i>sp</i>	10	9 = 9	Third star near; their direction points N. of it.
4	0 13,7	77 30	70	<i>np</i>	35	7,9	L. yellow. S. blue-green. Finely contrasted colours.
5	0 33,5	80 14—	20	<i>np</i>	25	10,11	
6	0 35,6	78 19—	45	<i>np</i>	15	9,10...11	} In the same field.
7	0 36,4	78 27—	45	<i>sf</i>	10	9,10	
8	0 39,5	78 16—	40	<i>nf</i>	5 or 6	12,13	A third star, larger, precedes. Nearly equal.
9	0 44,2	78 59—	10	<i>sf</i>	12 or 15	9,9½	
10	0 55,9	78 7 }	40	<i>np</i>	3	8,10	1 and 2 } Triple.
		40	<i>nf</i>	7 or 8	8,9	1 and 3 }	
11	1 2,0	78 5	3	<i>np</i>	5	11,12	—
12	1 5,0	78 0	45	<i>sp</i>	10	10,11	
13	1 14,9	78 1	40	<i>np</i>	10 or 12	8,13	A neat double-star: it is immediately preceded by a large nebula 11. 252.
14	1 20,9	78 16	5	<i>np</i>	8 or 9	9,10	
15	1 24,0	78 52	30	<i>nf</i>	12	10,13	A very neat d. star.
16	1 27,6	79 5	60	<i>np</i> or <i>sf</i>	20...25	10 = 10	

No.	R.A. 1825-0	N.P.D. 1825-0	Angle.	Quadrant.	Distance.	Magnitudes.	Remarks.
17	^h 1 ^m 29,8 ^{sec.}	[°] 78 ['] 42	[°] 5	<i>np</i>	5".7	9,10	A neat d. star.
18	1 34,5	78 47	50	<i>sp</i>	20..25	9,10	
19	1 46,5	79 5	85	<i>np</i>	20	12,13	
20	1 53,3	78 18	75	<i>nf</i>	25	10,11	
21	1 57,4	80 21	45	<i>np</i>	30	8,15	
22	2 6,0	78 45	10	<i>sf</i>	7..8	10,11	
23	4 9,4	97 26	2	<i>np</i>	30..40	10,11	
24	4 22,7	97 48	30	<i>nf</i>	25	9,12	
25	4 31,3	97 11	40	<i>np</i>	15	9,11	
26	4 34,3	96 49	35	<i>np</i>	10	10,11	
27	4 37,0	95 31	45	<i>sp</i>	75	9,9+	
28	4 42,8	96 31	65	<i>sp</i>	10	11,11+	
29	4 45,2	96 36	25	<i>np</i>	30	9,10	
30	4 48,1	96 1	0	<i>p</i>	60	8,8½	
31	4 55,0	95 24	..		15		
32	5 43,1	97 31	80	<i>sp</i>	20	9,12	3' <i>nf</i> is a star of 8th m.
33	5 48,4	97 2	80	<i>sp</i>	8	11,11½	
34	5 48,7	97 4	..				
35	6 0,2	97 28	30	<i>nf</i>	10..15	12,12½	
36	6 4,2	96 5	55	<i>sp</i>	30	11,12	
37	6 9,0	96::17	5	<i>np</i>	30	11,12	
38	6 14,2	95 46	30	<i>sp</i>	15	12,13	
39	6 18,3	97 24	25	<i>np</i>	30	7 or 8,10	
40	6 28,9	95 31	0	<i>f</i>	30	11,12	
41	6 33,3	96 25	45	<i>sp</i> or <i>nf</i>	20		
42	6 38,0	96 14	40	<i>nf</i>	30	9,11	A 3d star precedes of 9 m. making a very obtuse angle with the direction of the other two. } Triple. Large star, the intensest orange. Very beautiful.
43	6 40,5	96 14	5	<i>np</i>	20		
44	6 40,6	96 17	0	<i>f</i>	15	12,13	
45	6 45,9	96 11	5	<i>nf</i>	10	10,12	
46	6 48,6	95 56	7	<i>sf</i>	6	9,15	
47	6 57,3	95 56	15	<i>sf</i>	10		
			15:	<i>sf</i>	25:		
48	7 4,6	95 18	10	<i>sp</i>	40	10,11	
49	7 7,2	95 22	45	<i>nf</i>	5	10,11	

No.	R.A. 1825-0	N.P.D. 1825-0	Angle	Quadrant.	Distance.	Magnitudes.	Remarks.
50	^h m dec. 7 11,5	95° 25'	40°	<i>sp</i>	12"		
51	7 14,8	91 47	35	<i>sp</i>	10	10,13	
52	7 14,9	96 30	60	<i>sf</i>	10	10,11	1 and 2 } Triple. 2 and 3 }
			85	<i>sf</i>	6	11,13	
53	7 15,0	96 34	40	<i>sf</i>	15		
54	7 22,7	97 46	70	<i>nf</i>	20	9,12	
55	7 23,1	79 13	10	<i>sf</i>	12	9,12	1 and 2 } Triple. 2 and 3 }
			30	<i>sf</i>	6...8	12,15	
56	7 25,6	92 50	45	<i>np or sf</i>	4	11=11	
57	7 25,7	92 46			8	13=13	
58	7 29,7	92 48	20	<i>np or sf</i>	2	11=11	A very neat d. star.
59	7 35,5	93 17	40	<i>np</i>	6	11,13	
60	7 37,9	77 33	45	<i>nf</i>	4	13,14	
61	7 38,8	83 30	85	<i>sf</i>	7	10,11	
62	7 39,1	95 16	35	<i>sp</i>	30		An elegant triple star precedes.
63	7 39,7	90 6	30	<i>np or sf</i>	12...15	13=13	
64	7 40,2	90 9	45	<i>np or sf</i>	12...15	13=13	
65	7 40,6	76 45	30	<i>nf</i>	5	10,15	A star of 8 m. is 8' prec. and 2' n.
66	7 41,7	93 10	65	<i>sf</i>	30	9,11	
67	7 42,0	77 46	25	<i>sp</i>	5	12,13	
68	7 44,1	92 50	0	<i>f</i>	12...15	10,11	Twice observed; the first time through clouds.
69	7 45,2	78 15	40	<i>sp</i>	25	9,11	
70	7 45,3	78 15	25	<i>np or sf</i>	3	13=13	
71	7 46,9	93 1	45	<i>sp</i>	15-20	9,9½	Another similar d. star precedes.
72	7 50,0	85 18	85	<i>sp</i>	15	10,11	
73	7 50,3	90 12	15	<i>np</i>	10	11,13	1 and 2 } Triple. They form an exact equilateral triangle. 1 and 3 }
			75	<i>np</i>	10	11,15	
74	7 50,8	77 54	10	<i>np</i>	2 or 3	11,12	
75	7 51,0	92 44	0	<i>p or f</i>	25	10=10	
76	7 52,7	78 52	10	<i>nf</i>	4 or 5	11,12	A very neat d. star.
77	7 53,2	90 30	90	<i>n</i>	40	10,12	
			15	<i>sp</i>	5	11,12	1 and 2 } Triple. 3 and 2 }
78	7 54,3	93 12	70	<i>sf</i>	12	11,12	
79	7 56,6	93 21	35	<i>nf or sp</i>	5	11=11	A star 9 m. foll. 5'.
80	7 57,5	77 12	15	<i>sf</i>	20	10,12	

No.	R.A. 1825-0 h m dec.	N.P.D. 1825-0 °	Angle.	Quadrant.	Distance.	Magnitudes.	Remarks.
81	7 58,4	92 29'	30	<i>np</i>	20	11,12	
82	8 1,7	78 41	20	<i>nf</i>	20	11=11	
83	8 3,3	85 1	30	<i>sf</i> ? <i>np</i>	20	14,15	
84	8 3,3	84 58+	30	<i>sp</i> ? <i>nf</i>	10	13,14	
85	8 4,5	90 52+	20	<i>nf</i>	15-20	11,12	
86	8 8,2	94 16	40	<i>sp</i> or <i>nf</i>	10-12	12=12	1 and 2
			5	<i>sf</i>	12	12,18	1 and 3
			25	<i>sp</i>	15	12,15	2 and 4
87	8 8,5	82 58+	10	<i>sp</i> ? <i>nf</i>	4	10,12	
88	8 10,5	90 16	40	<i>sf</i>	20	9,13	
89	8 10,7	76 55+	40	<i>sf</i>	20	10,11	
90	8 12,9	93 15+	45	<i>sf</i>	15		1 and 2
			50:	<i>np</i>	50		1 and 3
91	8 13,5	77 22+	30	<i>nf</i>	15	13,14	
92	8 18,8	84 58	30		15	10,11	
93	8 18,8	77 13	15	<i>np</i> or <i>sf</i>	15	10=10	Twice observed.
94	8 20,8	93 26	45	<i>sp</i>	15...20	11=11	
95	8 21,0	83 58	45	<i>np</i>	25	11=11	
96	8 23,3	90 23	70	<i>nf</i>	30	9=9	1 and 2
			55	<i>sf</i>	40	9=9	1 and 3
97	8 24,7	76 31+	5	<i>np</i>	7...8	10,10½	Twice observed.
98	8 28,7	91 50-	15	<i>sf</i>	2	11=11	
99	8 29,0	96 11+	50	<i>sp</i>	80...90		Both large stars.
100	8 30,4	83 36	65	<i>nf</i>	25	7,8	Quadruple. 3 and 4 are each of 20 m. and form with 1 and 2 a segment of a circle bending round to the <i>nf</i> side. Is IV. 54 now first observed as quadruple.
101	8 32,0	78 28	40	<i>nf</i>	4	11,11+	Nearly equal. Twice observed.
102	8 32,2	91 35	30	<i>sf</i>	6	11,14	These two are in the same field, and pointing nearly towards each other.
103	8 32,5	91 37	25	<i>np</i>	6	11,14	
104	8 35,5	75 49	15	<i>nf</i> ? <i>sp</i>	25	10,11	
105	8 35,6	76 7+	25	<i>sp</i>	20	11,12	
106	8 39,7	93 19	70	<i>np</i>	...	6, ...	
107	8 41,6	93 33-	25	<i>nf</i>	20...25		L. pale yellow, S. blue. It is 241 <i>Monocerotis</i> of BODE'S Catal.

No.	R.A. 1825-0	N.P.D. 1825-0	Angle	Quadrant.	Distance.	Magnitudes.	Remarks.
108	8 43,7 ^h m dec.	92 23—	20	sp	2	15,16	Among several stars of 10 m.
109	8 44,7	76 42	10	np	3	11=11	
110	8 48,9	77 28	50	np	10::	4 or 5,20	α^2 <i>Canceri</i> . L. white. S. red. Twice observed. Extremely delicate.
111	8 50,9	90 55	30	sp	20	9,10	Their direction points N. of a star of 10 m.
112	8 51,1	75 27	70	np	10	12,13	
113	8 51,5	76 27+	50	sp	20	13,14	
114	8 54,6	93 23+ }	30	np	15...20	10,11	1 and 2 } Triple. 1 and 3 }
			15	sp	20...30	10,14	
115	8 54,6	75 0	40	sf	25	9,10	
116	8 55,3	92 12	45	nf or sp	30	8.9=8.9	
117	8 56,2	93 18	2	nf	10	9,10	
118	8 57,3	73 45	50	np	2...3	11,12	
119	9 0,1	90 50	40	np	50	8,10	L. orange. S. purple: good colours.
120	9 2,5	93 36	75	nf	30	10,11	
121	9 3,2	79 26	20	nf	1::	10,...	Both red. Observed long and attentively. Remained satisfied of its being double after trying a variety of diaphragms.
122	9 4,2	78 8+	2	sp or nf	6...8	10=10	A v. neat star. Twice observed.
123	9 4,3	91 36 }	55	sp	15...20	10,11	1 and 3 } Triple. 1 and 3 point above (S. of) a very faint d. star at 3' dist.
			80	sf	10...15	10,16	
			5	nf	20	10,11	
124	9 6,1	83 45+ }	75	sp	50	10,13	1 and 2 } Triple. 1 and 3 }
125	9 8,0	76 38+	30	np	15	12,13	
126	9 8,1	89 54+	55	nf	30	9,10	
127	9 8,2	95 5—	15	np	8	12,13	
128	9 8,4	77 46	15	np	30	6,18	γ <i>Canceri</i> of Bode's Catal.
129	9 10,2	83 9+	40	sp	8	11,12	
130	9 10,4	79 13	45	nf	6	9,13	
131	9 11,2	90 53	25	sf	15	10,11	
132	9 12,5	93 20	40	sp	10	9.10, 15	
133	9 13,6	83 56	40	np or sf	12	11=11	
134	9 15,2	77 38—	20	sp	20	11,12	
135	9 15,6	73 48+	40	nf	8	13,14	
136	9 16,5	75 43	30	np or sf	15	12=12	

No.	R.A. 1825-0	N.P.D. 1825-0	Angle.	Quadrant.	Distance.	Magnitudes.	Remarks.
137	^{h m dec.} 9 20,5	[°] 84 40	[°] 80	<i>sp or nf</i>	10	9.10=9.10	
138	9 21,7	78 38+	10	<i>sp or nf</i>	15...20::	10=10	
139	9 23,8	84 58	30	<i>sp</i>	15	9,10-11	
140	9 27,9	83 51	5	<i>sp</i>	25	12,13	
141	9 36,3	85 3	0	<i>f</i>	30	9,11	1 and 2 } Triple: the stars form 1 and 3 } an isosceles triangle.
			60	<i>sf</i>	40	9,12	
142	9 36,9	73 38+	50	<i>sf</i>	12	10,11	
143	9 37,7	94 27	30	<i>sp</i>	8...10	15,16	
144	9 45,7	78 57	65	<i>np</i>	10	11,12	
145	9 46,1	79 4-	40	<i>sp</i>	15	9.10,11	Points to n. of a star 3 of 11 m.
146	9 46,6	93 58	30	<i>sf</i>	15	10,11	
147	9 49,4	90 45+	45	<i>sp or nf</i>	20	10=10	
148	9 50,9	92 37+	50	<i>nf</i>	3...4	10,16	Very delicate.
149	9 51,9	84 9	5	<i>sp</i>	30	—	L. red. S. purple.
150	9 56,1	94 49	35	<i>np</i>	8...10	13,14	
151	9 56,8	79 27+	55	<i>nf</i>	5	12,14	
152	9 58,2	83 34	—	—	—	—	
153	10 1,2	91 6	80	<i>sp</i>	12	11,12	1 and 2 } Triple. 1 and 3 }
			25	<i>sf</i>	12	11,18	
154	10 5,6	90 19	60	<i>sf</i>	10...12	11,12	
155	10 6,2	74 44+	55	<i>sf</i>	15	11,12	
156	10 6,7	77 7+	60	<i>np</i>	10	10,11	1 and 2 } Triple. An equilateral 2 and 3 } triangle.
			90	<i>n or s</i>	10	11=11	
157	10 8,2	92 33	30	<i>np</i>	15	10,13	S. blue.
158	10 10,5	75 40	85	<i>sf</i>	15	9,12	
159	10 11,1	77 46+	75	<i>nf</i>	35	8,10	L. red. S. blue. Twice observed, and the colours noted each time.
160	10 16,3	93 27	25	<i>np</i>	5...6	12,13	
161	10 17,6	77 56+	45	<i>sp</i>	20	12,13	
162	10 20,8	74 28-	60	<i>np</i>	15...20	9,11	
163	10 20,8	93 1	70	<i>np</i>	15...20	9,10	
164	10 24,3	83 12	60	<i>nf</i>	20	11,12	
165	10 26,8	77 28+	60	<i>np</i>	3	8,9	
166	10 30,9	77 5+	10	<i>np</i>	3	11,13	1 and 2 } Triple. 1 and 3 }
			30	<i>nf</i>	20	11,12	

No.	R.A. 1825-0	N.P.D. 1825-0	Angle.	Quadrant.	Distance.	Magnitudes.	Remarks.
167	^h 10 ^m 31,2 ^{sec.}	77° 2+	45	np	30"	9,13	L. white. S. blue.
168	10 40,3	76 9	5	np or sf	10	8=8	
169	10 42,1	93 15	20 35	nf np	2 25	13,14 13,15	1 and 2 } 1 and 3 } Triple.
170	10 52,8	74 26+	15	np	12	9,10	
171	10 53,1	79 10	5	sp	10...12	10,11	} Both in the field at once, each twice observed.
172	10 53,1	79 19	3	np	10	10=10	
173	10 53,6	92 35	85	sf	30	7,20	The small star is the <i>Minimum visibile</i> .
174	10 55,2	76 25	70	nf	30...40	6,9	L. red. S. blue.
175	10 58,0	78 9 78 4	7 10	np np	5...6 5...8	10,11 9,10	{ Twice observed; but in one of the observations evidently a mistake of 5' in reading the P. D. index. The Right Ascensions agree exactly.
176	11 0,2	77 58	60	nf	10...12	10,12	
177	11 0,4	92 28+	20	sf	2		Hardly divided with the sweeping power.
178	11 5,5	91 27	75	nf	10	11,13	A star 9 m. precedes.
179	11 10,0	77 33	45	np	6	12,13	
180	11 15,2	74 52	70	nf	25	9,12	
181	11 23,2	92 34	40	np or sf	12...15	9-10=9-10	
182	11 26,2	77 34	15	sp	10	13,14	
183	11 29,0	76 5	70	nf	60		L. Red. S. bluish.
184	11 30,0	79 1+	50	sf	25	11,12	
185	11 30,8	79 17+	55	nf	25	11,12	
186	11 31,3	92 22	25	np	5	11,12	A star 9 m. is 1' S. and 1" prec.
187	11 32,2	79 12	45	nf	5	11,13	Points to N. of a star 3, of 10 m.
188	11 37,5	90 15	45	sf	6	15,16	Very minute.
189	11 39,3	92 8+	35	sf or np	20	11=11	
190	11 40,9	93 52	0	p	18	9,13	L. yellow. S. blue.
191	11 42,3	77 3	10	sp		10,12	Their direction makes an angle of 175° with a star 3, nf.
192	11 43,1	92 1-	30	nf	15	11,14	
193	11 46,4	78 1+	70	nf	8	11,13	
194	11 47,6	93 38	80	sp	12	9,10-11	
195	11 50,5	92 26	20	nf or sp	10	14,...	
196	11 50,7	90 32	5	np	15	11,11+	{ Nearly equidistant between two small stars 40° sf and 40° np. Twice observed. Places agree, but estimations differ a good deal.
197	11 51,9	77 26+	15	np or sf	10...20	12=12	

No.	R.A. 1825-0	N.P.D. 1825-0	Angle	Quadrant.	Distance.	Magnitudes.	Remarks.
	^h ^m ^{sec.}	[°] [']	[°]		^{''}		
198	11 56,6	94 52-	0	<i>p</i>	80	8,10	L. yellow. S. blue. Good colours.
199	11 58,6	76 23	20	<i>nf</i>	10	9,14-15	Twice observed. The places agree well, but the estimated angles differ 20". That set down here is a mean.
200	12 1,5	91 16	5	<i>np</i>	30	9,9½	
201	12 1,7	93 46	0	<i>f</i>	15	9,10	
202	12 2,8	52 55+	80	<i>np</i>	40	6,6½	
203	12 5,3	94 44	65	<i>np</i>	25	6,19	1 and 2 } Triple. Is 78 (Bode)
			65	<i>sp</i>	60	6,14	1 and 3 } <i>Virginis</i> .
204	12 6,0	90 22-	35	<i>nf</i>	30	8-9,11	L. white. S. deep blue.
205	12 9,8	77 14	40	<i>sp</i>	8	10,11	A third star 11 m. directly N.
206	12 10,1	90 39+	30	<i>np</i>	7	12,13	Twice observed.
207	12 11,8	74 36	10	<i>sf</i>	20	10=10	
208	12 14,8	74 5-	70	<i>sf</i>	15	10,11	
209	12 15,0	92 4+	50	<i>sf</i>	25	9,9+	
210	12 18,0	92 33+	50	<i>sf</i>	20	9,10	Very delicate, a diagram made at the time, places the small star <i>nf</i> .
211	12 23,4	90 56	5	<i>np</i>	3	12,13	
212	12 24,6	78 49+	5	<i>sp</i>	30	9,9	
213	12 31,7	73 47-	45	<i>sp</i>	15		
214	12 32,8	90 30	0	<i>f</i>	60±	3,15	1 and 3. <i>γ Virginis</i> , has a 3d star following it very nearly in the parallel.
215	12 34,7	93 50-	15	<i>np</i>	2...3	12,14	1 and 2 } Triple. Form nearly an equilateral triangle.
216	12 36,7	74 41+			30	8,9	
217	12 37,1	78 53	70	<i>sf</i>	25		
			50	<i>sp</i>	25		
218	12 44,7	71 5	5	<i>sp</i>	10	11,12	Large star yellow. S. blue.
219	12 47,2	93 55	65	<i>sf</i>	4	7-8,9	
220	12 56,9	74 20+	55	<i>nf</i>	5	8,18	
221	13 4,4	77 51+	75	<i>sp</i>		9,14	
222	13 10,3	77 25	55	<i>sf</i>		8,10	1 and 2 } Triple.
223	13 11,6	73 31	60	<i>np</i>	35...40	9,11	
224	13 13,3	71 19+	45	<i>sp</i>	12	9,11	
225	13 13,3	78 37+	85	<i>sp</i>	15	12,13	
			40	<i>nf</i>	30	12,...	1 and 3 }
226	13 14,9	75 5-	55	<i>nf</i>	6	12,13	1 and 3 }
227	13 17,7	78 17	45	<i>np</i>	60		
228	13 26,9	78 53+	80	<i>nf</i>	60	7,8	
229	13 33,3	77 8+	45	<i>nf</i>	15	12,13	

No.	R.A. 1825-0	N.P.D. 1825-0	Angle	Quadrant.	Distance.	Magnitudes.	Remarks.
230	^h 13 ^m 34,6	71° 21'	50	sf	15	10,11	
231	13 37,7	77 29	15	nf	15...20	11,12	
232	13 39,0	71 40+	75	np	20...25	4,5,16	ε Bootis. Twice observed, very delicate. The small star may, however, be seen with illumination.
233	13 48,7	77 16+	45	np or sf	15...20	10=10	
234	14 4,6	75 35	80	np	2	11,12	
235	14 12,9	75 37	10	np	5	11,13	
236	14 14,1	77 12	10	np	15	12,13	
237	14 21,0	78 33	50	nf	15	11,12	
238	14 22,6	75 29+	15	sf	20	10,11	} Triple. The three stars exactly in a line, the middle the smallest.
			15	sf	35	10=10	
239	14 26,0	75 0+	30	sf	15	10,11	
240	14 29,5	74 20+	45	sf	15	8,9	
241	14 40,1	77 10-	60	nf	20	9,10	
242	14 45,2	77 37+	50	np	10	10,11	
243	14 50,1	53 48	65	nf	12	8,13	
244	14 53,7	73 31+	85	sp	25	8,8-9	
245	14 55,8	53 26+	3	sp	6	12,12	
246	14 56,7	75 34+	45	sp	4	10,11	
247	15 0::,2	78 23	40	nf	15	10,11	
248	15 0,9	75 0	5	np	8	10,11	} Triple. 1 and 2 } 1 and 3 }
			30	sf	30	10,18	
249	15 4,0	71 52	45	sf	10	12,12	
250	15 5,0	52 55	35	sf	20	9,11	
251	15 13,5	53 23	30	sp	20	11,11	
252	15 16,7	75 23+	10	sf	8	9,10	} Triple. 1 and 2 } 1 and 3 }
			5	sf	20...30	9,12	
253	15 21,2	78 56	80	nf	15...20	8,9	L. white. S. blue.
254	15 22,2	73 41+	15	np	10	10,10 $\frac{1}{2}$	} Quadruple. 1 and 2 } 2 and 3 } 2 and 4 }
			00	n	25	10 $\frac{1}{2}$, 10 $\frac{1}{2}$	
			15	sp	30	10 $\frac{1}{2}$, 15	
255	15 31,6	53 10	10	sp or nf	15	7=7	
256	15 31,8	71 39	5	sf	2::		
257	15 39,9	53 0+	50	np	40	7,8	
258	15 50,4	53 25	15	sp	15	9,10	
259	16 1,0	53 43-	60	sf	10	12,13	

No.	R.A. 1825-0 h m sec.	N.P.D. 1825-0 ° ' "	Angle	Quadrant.	Distance.	Magnitudes.	Remarks.
260	16 5,5	52 8'	45	<i>nf</i>	15	10,11	
261	16 22,2	52 12	2	<i>nf</i>	15	10,11	
262	16 55,0	51 49	40	<i>sf</i>	30		} In the same field, and also a third.
263	16 55,3	51 51	30	<i>sf</i>	15...20	9,11	
264	17 1,5	53 49	85	<i>sp</i>	5	9,11	
265	19 3,4	92 40+	15	<i>np</i>	5	10,11	1 and 2
			25	<i>np</i>			1 and 3
			90	<i>n</i>			1 and 4
266	19 10,3	91 52-	5	<i>sp</i>	5	12,13	A suspected Stellar nebula in the field: dist. about 10', 30" <i>sp</i> . A star half way serves to direct the eye. Sky a little hazy.
267	19 22,0	90 48+	60	<i>np</i>	15...20	8,12	L. white. S. purple.
268	20 18,6	79 19	30	<i>sp</i>	15	10,12	
269	20 23,3	79 19	35	<i>sp or nf</i>	15...20	9=9	Possibly STRUVE's 680, but disagreeing much in R. A. and P. D.
270	20 27,2	103 20	82	<i>sp</i>	15	9,10	1 and 2
			90	<i>s</i>	30	9,15	1 and 3
			75	<i>sf</i>	40	9,15	1 and 4
271	20 39,0	79 19	45	<i>sf</i>	3	10,11	
272	20 54,0	77 43	80	<i>sp</i>	15	9,10	
273	20 56,6	77 58+	5	<i>np</i>	15...20	9,10	
274	20 58,7	78 49	3	<i>sf</i>	5	9,10	
275	20 59,3	75 18-	87	<i>nf</i>	20	9,11	
276	20 59,9	78 28	30	<i>sp</i>	5	12,13	
277	21 3,2	78 19	45	<i>np</i>	8	10,11	
278	21 5,4	79 59	15	<i>sp</i>	20		
279	21 9,2	78 24	25	<i>np or sf</i>	3	11=11	Direction points N. of a star S.
280	21 11,9	103 3+	80	<i>sf</i>	70		
281	21 12,9	73 59+	60	<i>np</i>	12...15	9,10	
282	21 15,7	78 8	30	<i>nf</i>	10...15	9,20	
283	21 18,4	101 34	35	<i>nf</i>	10...12	13,14	
284	21 21,6	75 45-	50	<i>np</i>	30	9,11	S. blue.
285	21 36,4	80 8	30	<i>nf</i>	2...3	11,12	
286	21 41,8	78 30	15	<i>sp</i>	12	9,11	S. bluish.
287	21 42,2	74 49	50	<i>sp</i>	10	13,14	
288	21 45,6	74 56-	40	<i>nf</i>	15	11,12	

No.	R.A. 1825-0	N.P.D. 1825-0	Angle.	Quadrant.	Distance.	Magnitudes.	Remarks.
289	^h 21 ^m 52,8	[°] 77 ['] 43	[°] 50	np	40	5.6, 12.2	Is FLAMSTEED's 20 <i>Pegasi</i> .
290	21 56,4	79 21	3	sf	5	11, 12	} Two elegant double stars in the field together.
291	21 56,4	79 23+	5	sf	3	10, 11	
292	22 5,9	73 42	35	np	10	7, 10	L. yellow. S. blue.
293	22 8,2	77 54-	1	np	15	9, 11	S. bluish.
294	22 13,3	75 37	10	sf	20	9, 10	
295	22 16,7	101 17	{	45	sf	20...30	1 and 2
				85	sp	8	2 and 3
296	22 22,0	77 45+	50	sp	12	9, 11	} Triple.
297	22 25,0	74 35-	75	sf	5...10	10, 11	
298	22 25,1	78 24	87	sp	30	10, 10½	L. ruddy.
299	22 31,8	73 44	15	np::	15...20		Foggy at the time of obs.
300	22 36,1	79 17	50	sp	20	11, 12	
301	22 37,9	78 43+	30	sf	11	5, 18	ξ <i>Pegasi</i> . Twice observed. The small star bears illumination well, and is therefore blue. The estimated angles differ 20°. That here set down is a mean between them.
302	22 44,6	80 5-	60	np	4...5	9, 12	
303	22 46,5	78 1	70	nf	10	11, 12	
304	23 1,2	80 13	75	sf	10	9?.....	
305	23 2,9	103 48	6	sf	5	11, 11+	
306	23 3,0:	76 28	5	sp	60::		L. white. S. purple.
307	23 10,5	77 30	40	np	20	9, 10	
308	23 10,6	77 32	20	np	15	10, 11	
309	23 10,7	77 30	45	np	10...12	11, 12	
310	23 13,3	103 56	45	np	20	10, 11	A very pretty d. star.
311	23 20,2	73 38	45	np	10		Has the nebula II. 242 in the field with it.
312	23 23,5	78::29	0	f	10	10, 11	The degree perhaps mistaken.
313	23 24,9	78 41	5	np	12	10, 11	
314	23 26,5	77 49					Double. No particulars.
315	23 28,7	78 22+	30	sp	25...30	8, 8	
316	23 29,0	104 1	0	f	60	7, 11	L. white. S. blue, marked contrast of colour.
317	23 29,4	78 5	{	50	sp	10	1 and 2.
				5	np	15...20	2 and 3.
318	23 41,4	74 16	0	p or f	12	Equal	Δ R. A. = 1' of time.
319	23 42,9	79 41-	10	np	12	9, 11	
320	23 43,6	79 2	10	np	30	8, 9	
321	23 48,6	79 30	35	sf	15	7, 11	423 (Bode) <i>Pegasi</i> .

2. *Observations of the second Comet of 1825.*

The comet which appeared in the early part of last year in the constellation Taurus, where it remained almost stationary for a great length of time, having increased about the beginning of October so as to become a very conspicuous and splendid object, afforded me an opportunity I had long desired,—of examining under favourable circumstances, the physical constitution of one of these interesting bodies, with the advantage of the light of my 20-feet reflector, and that high degree of distinctness with which I have usually found it to define celestial objects of a sensible magnitude. On the 3rd of October the moon (which was then about the third quarter) was so near it as in great measure to efface its light, rendering the larger instruments unavailable. I therefore contented myself on that evening with turning on it a 7-feet Newtonian reflector (aperture 6 inches),—the observation with which is here extracted from my Journal.

“7-feet. Head large, and pretty dense,—not however condensing very much in the approach towards the centre, but suddenly coming to a distinct stellar nucleus, which is nearly as bright, only not quite so sharp, as a star of the 9th or 10th magnitude in the field with it.—The nucleus is not quite in the centre of the head, but rather toward the tail side.”

The distinctness of vision this night was very uncommon. Four of the satellites of Saturn were well seen, and the 5th by glimpses; and the two extremely feeble stars intermediate between the double stars 4 and 5 *Lyræ* were also seen for the first time with this telescope. The stellar point recorded in the above observation, recalled a similar appearance noticed with the same telescope in the comet of 1819, and which I then, as now, regarded as a solid nucleus.

The next night, the moon being somewhat less troublesome, I turned on it a 10-feet Newtonian reflector, in which “there appeared a star-like appearance in it, but not nearly so sharp and sparkling as in the 7-feet” the night before. “Turning,” however, “the 20-feet to it, the illusion of a sharp, starlike nucleus was completely destroyed. The comet becomes a milky irresolvable nebula, very suddenly much brighter in the middle *almost* to a planetary disc, but with positively no sharp outline. The brightest part is 10" to 15" in diameter, and is round; but in its centre there is not the least suspicion of a brilliant point.” “Many small stars near. All these are sharply defined points. The light of the comet is very vivid, and illuminates the cross-wires.

It is altogether a magnificent sight, and is quite satisfactory as to the nucleus." The tail, this evening before the rising of the moon, was estimated at 7 or 8°.

"Oct. 7, 1825. 20-foot reflector. The comet.

Its nucleus. It has no sharp, star-like centre, but a much brighter yet quite milky, round kernel of about 15" to 20" in diameter, shading insensibly but almost suddenly away.

Its coma is irregular. On the preceding side it extends further, and is partly detached as at *a*.

Tail distinctly bifid, divided into two great branches *b*, *c*, which go off immediately from the nucleus at an angle of 45° with each other. The preceding branch *c* is shorter and irregular, being subdivided at *d*. The following one *b* is long, regular and predominant, and forms the true tail."

Annexed (Plate VI.) is a copy of a drawing made at the time of observation, in which these peculiarities are represented.

I was very desirous to examine the state of the coma and tail on the next night, with a view to see whether any change in the relative lengths of the two branches took place; but the weather proved unfavourable, and before I could again get a good view of it, it was gone too far south to be observed.

3. *Of the great Nebula in Orion.*

The nature and uses of the nebulous matter which exists in such abundance and variety of forms in the heavens, is a problem of much interest to astronomers, but at the same time of the greatest obscurity. Among all the theories which may be imagined respecting it, that which regards it as a self-luminous or phosphorescent material substance in a highly dilated or gaseous state, but gradually subsiding by the mutual gravitation of its molecules into stars and sidereal systems, must certainly in the present state of our knowledge be looked upon as the most probable;—but so wide is the field of conjecture, and so uncertain the analogies we have to guide us, that we shall do well for the present to dismiss hypothesis, and have recourse (perhaps for centuries to come) to observation.

The nature of nebulae, it is obvious, can never become more known to us than at present; except in two ways,—either by the direct observation of changes in the form or physical condition of some one or more among them, or from the comparison of a great number, so as to establish a kind of scale or gradation from the most ambiguous, to objects of whose nature there can be no doubt.

The latter method has been attempted on a very extensive scale by my father in his later papers on the construction of the heavens ;—and if some links in the chain of progression appear less distinctly marked than others, yet on the whole, there is sufficient appearance of gradation, sufficient absence of a *saltus* of any extent, to authorize the idea of at least the possibility of an imperceptible transition from the nebulous to the stellar state.

But to all cosmological reasoning drawn from the fact of such observed gradation, there is one obvious objection ; namely, that however completely a scale of gradation between a multitude of individuals existing simultaneously may be made out, this affords no ground whatever for supposing any one among them to have passed, or to be capable of passing, through all the other states, or for concluding them to be in a course of progress from one state in the series to another.—There are infinite varieties in the modes and forms of animal life, from man down to the lowest orders ; and some naturalists would willingly establish a progression among them, beginning with the simpler, and going on to the more complicated forms ;—but so long as no such progress can be seen to go on,—so long as for generation after generation every animal succeeds to all the imperfections of his parent, the utmost that we can admit is, that such a formative *nisus* *may* have once existed, and acted in the progressive manner supposed, but that all such progression has long since ceased in the present state of nature.

The case, however, would be different if we could procure authentic evidence of such changes in the form, brightness, or physical condition of any particular nebula, as to establish the fact of its transition from one state to another, and to show an advance to a condition of greater maturity, or compression, to have really taken place. Such evidence is however, unfortunately, very difficult to procure. The same nebula viewed on the same night with different telescopes, presents very different appearances, according to the different degrees of light, distinctness and magnifying power employed ;—so different, indeed, as to be scarcely recognizable for the same object : and if viewed on different nights with the same telescope, atmospheric circumstances will make hardly less variation in it ; and the presence or absence of the moon is equally or more efficacious, in changing entirely the shape and magnitude of its visible outline. If we add to this the extreme difficulty of representing such appearances on paper, and the hardly inferior one of getting them faithfully engraved ;—if we add too, that astronomers are seldom draftsmen, and have hitherto evidently (with one honourable exception) contented

themselves with very general and hasty sketches, it will be no matter of surprise that the published engravings of these objects present a mass of contradictions, and for the most part offer as little resemblance to the objects themselves as to each other.

The most remarkable of the nebulae are, that in the sword-handle of Orion, and that in the girdle of Andromeda, near the most northern star in it. The former was discovered by HUYGENS, and figured by him in his *Systema Saturnium* in 1659. Since that time it has been examined and described with more or less minuteness by DERHAM, GODIN, FOUCHY, MAIRAN, PICARD, LE GENTIL, and MESSIER; the four latter of whom have given engravings of it. Those of HUYGENS and PICARD will be found copied in M. LE GENTIL's paper on the subject of nebulae, in the *Memoirs of the Academy of Sciences of Paris*, (*Histoire de l'Academie*, 1759, p. 453—471.) together with his own figures. MAIRAN's is copied in LALANDE's *Astronomy*, vol. I. fig. 21, from his work on the Zodiacal Light; and MESSIER's is to be found in the *Histoire de l'Academie*, 1771, attached to his valuable collection of nebulae and clusters of stars, p. 435—461.

Of all these, the last is the only one which appears to have been made with any care, and in which the least approach to the present form, as seen with powerful telescopes, can be traced. It is moreover the only one in which any attempt is made to represent the different degrees of intensity in the light of different parts, and its shading away imperceptibly into the dark ground of the heavens. The others are all of an uniform brightness, and with well-defined outlines, which therefore must be regarded as belonging to the maximum of light as seen with their telescope, and can afford but very vague notions at best.

Before proceeding to comment on these drawings, it will be well to have before us a careful and correct representation of its actual state. Such a one is that in the annexed drawing (Pl. VII.), which has been made from a set of drawings and notes taken in several nights' observations in the 20-foot reflector with its full aperture in favourable nights, and in the absence of the moon,—but principally on that of Feb. 1, 1824,—and compared afterwards with the real object, noting and correcting what stood in need of alteration. The last of these comparisons was made at Slough on the 3rd of March 1826, with the advantage of Mr. RAMAGE's judgement as well as my own; when all the essential features represented in the drawing, from which this has been

finally and very carefully copied, were distinctly seen by us both, and allowed to be truly depicted.

In order, however, not to disfigure the drawing with numbers or writing, or preposterous representations of stars, as well as for convenience of reference, I have also added a kind of map (Pl. VIII.), representing the whole as a constellation, in which the parts are named after a rude resemblance which the whole nebula presents to the head, snout and jaws of some monstrous animal,—a resemblance which has also suggested itself to GENTIL. If any one should think this too ridiculous, he may adopt the nomenclature which has been used in selenography, of naming the various regions after celebrated astronomers. Thus he may attach to the brightest and most remarkable region in the nebula, the name of its first discoverer, HUYGENS,—to the crest or southernmost region, that of LE GENTIL, who first perceived it to be separated from the rest by the dark interval, which I have therefore called *Sinus Gentilii*,—to the long winding branch which runs off to the S.S.E. the name of MESSIER, who first noticed its existence,—to the nebulous star on the N.N.E. of the great nebula, that of MAIRAN, who first described it as nebulous ;—and so on.

I now come to describe the various parts of the nebula, in order to supply in some measure the unavoidable imperfections of every drawing, and to notice the discrepancies between this and former accounts.

1. *Trapezium*. These four stars I shall designate by α , β , γ , δ . They form the quadruple star θ *Orionis*. Their relative position is unaltered apparently. Mr. SOUTH has given measures of their angles of position and distance in his paper (*Phil. Trans.* 1826, Part i.).

The nebula, which is very bright in the parts surrounding the trapezium, seems (whether by the effect of contrast with the dazzling light of these stars, or from a real deficiency in nebulous matter) to have retreated from immediate contact with them, so that they appear in some degree insulated, and with a darkness around them. This would agree with the idea of a subsidence of the nebula into the stars by gravitation ; but it is probably only a deception*. In such cases every one remembers the celebrated line,

“ Dark with excessive light his skirts appear.”

* However, in the nebula R.A. $17^h 52^m$, N. P. D. $113^\circ 1'$ in Sagittarius, which belongs to the

Mr. POND has made the same remark of the apparent insulation of the trapezium as seen with Mr. RAMAGE'S 25-feet telescope now at Greenwich.

2. *The Huygenian Region.* The figure of this portion is nearly a right-angled triangle. The forehead and occiput form exactly a right angle, and the confine between bright light and comparative darkness on these sides is extremely well defined. The line of the forehead is continued across the insertion of the trunk, offering an appearance as if one well-defined nebula were laid upon another, which graduates away insensibly into what may be called the subnebulous region.

The Huygenian region is represented in MESSIER'S engraving as of a uniform brightness: but this is very far from being the case, as its illumination is extremely unequal and irregular. I know not how to describe it better, than by comparing it to a curdling liquid, or a surface strewed over with flocks of wool, or to the breaking up of a *mackerel sky* when the clouds of which it consists begin to assume a cirrous appearance. It is not very unlike the mottling of the sun's disc, only (if I may so express myself) the grain is much coarser, and the intervals darker; and the flocculi, instead of being generally round, are drawn out into little wisps. They present, however, no appearance of being composed of small stars, and their aspect is altogether different from that of *resolvable nebulae*. In the latter we fancy by glimpses that we see stars, or that, could we strain our sight a little more, we should see them. But the former suggests no idea of stars, but rather of something quite distinct from them.—I am thus diffuse in describing this, because no single simile exactly represents the object, and on account of the very remarkable nature of the phenomenon, which certainly forcibly suggests the notion of a breaking up and separation of the nebula into distinct parts, and not less so, that of matter feebly coherent floating in a transparent atmosphere of equal density and agitated by winds. I do not find it described or noticed in any former account; but this must be attributed to the want of light in the telescopes used, for it is not to be seen with a 7-feet Newtonian of 6 inches aperture. In MESSIER'S figure the frontal line is very indistinctly marked; and instead of preserving its direction all along, is made to form an obtuse angle or curve

same class of objects as that in Orion, the idea of an absorption by the double-star in its middle is very forcibly suggested. This nebula is broken into three parts, and the lines of division meet in a vacancy, in the middle of which is situated the double-star. This curious object has perhaps a proper motion.

following the course of the three stars, ϵ , ζ , η , which are there represented as situated exactly on the edge of the brightest part. This leads us to

The Subnebulous Region, in which are situated the stars ϵ , ζ , η , λ , ψ . It is occupied by a faint nebulosity, insensibly and very gradually shading away into darkness. If we compare the figures of HUYGENS, PICARD, MESSIER, and that here presented, it would seem as if the brighter portion of the nebula had formerly extended over this space, and were now contracting and receding towards the trapezium; for in the figures of HUYGENS and PICARD, the three stars are represented as deeply immersed within the nebula, and the division which contains them is by far the most considerable portion of the whole: but as in these there is no variation of shade, it is impossible now to say where they fixed the limit of what was to be considered as nebula. In MESSIER's figure they are placed precisely on the edge of the most luminous portion, as above mentioned; while at present they are completely detached from it, and the line which they form makes an angle of at least 45 or 50° with the frontal line. This *appears* conclusive, as the withdrawing of the nebula would seem to have gone on progressively. Unluckily, however, the observations of LE GENTIL will not allow of this conclusion. His figure, drawn on March 10, 1758, and therefore sixteen years before MESSIER's, represents it in this respect, just as it stands at present, the line of the three stars forming the same angle with the frontal line; and to take away all doubt on the subject, he says expressly, "*Les trois etoiles que Messrs. HUYGENS et PICARD, et après eux GODIN et DE FOUCHY, ont vues en ligne droite dans ce que j'appelle la machoire inferieure*" (our upper jaw), "*nous ont paru totalement detaches de la nebuleuse,—elles etoient sur une même ligne droite, et elles faisoient une angle considerable avec la machoire inferieure.*" On another night, "*Je trouvai,*" he says "*.... que les trois etoiles qui dans les figures de Messrs. HUYGENS et PICARD sont dans la machoire inferieure, faisoient avec elle un angle d'environ 40° ;*" the meaning of which he further explains, by a reference to letters in his figure. This observation was made with a 6-feet Gregorian telescope, which of course would only permit the brightest part to be distinguished; but on turning on it telescopes of 8 and 16 feet, he assures us that the three stars then appeared exactly placed as HUYGENS and PICARD represented them, *i.e.* quite within the nebula; and of this appearance he gives a separate figure.

These observations completely destroy the weight of any conclusion as to a change, drawn from the comparison of HUYGENS's figure with MESSIER's or

my own. But how MESSIER could have overlooked the very remarkable and striking effect of the frontal line and its oblique position with respect to the three stars, with LE GENTIL's figures and description before him, and his attention specially turned to the point, and with a telescope capable of showing the other peculiarities so well, is certainly surprising, and may lead to a suspicion that this line has really since become more definite, and that the nebula has retreated. The star ψ is not in his figure.

Sinus Gentilii. The totally dark recess designated by this name is represented by LE GENTIL as a very long narrow exactly rectangular cut, commencing, not as at present, at a considerable distance, to the south-west of the star ϵ , but nearly opposite to it, so that the line joining ζ and ϵ produced actually enters the sinus, and makes an angle with its general direction much less than at present,—hardly more than 15 or 20° in his figure. The angle too between the frontal and occipital line, which at present is just a right angle, is represented by him as very obtuse—about 135° ; MESSIER makes this sinus dim and indistinct, but an approach to the rectangular form of this part (the vertex) of the nebula is perceivable.

Crista seu Regio Gentiliana. Represented by LE GENTIL as an exact well-defined rectangle, whose length is nearly twice its breadth, and bounded on the north following side by the sinus which runs in the direction of its length. His figure presents no resemblance in this part to MESSIER's; the rectangle is made to adhere to the nebula by a thin neck of less breadth than the sinus.

In MESSIER's figure, a very much greater extension is to be remarked in the crest. In his figure it includes the star marked 2 , and its boundary passes off to the south preceding, a little below the star marked 1 , (which stars he has been at the pains of laying down by actual micrometrical measure, and which are inserted in my drawing from his measures) and considerable strength and boldness is given to its outline in this part. The portion next to 1 is represented even as brighter than the great branch (*Brachium Messieri*). At present, if nebulosity exists in that region (and perhaps hardly any part of the sky for some degrees round can be regarded as quite free from it), it is certainly very faint; and if MESSIER's figure is to be trusted, a material alteration here must have taken place. With respect to this latter point, he must be allowed to speak for himself: "Le dessin de la nebuleuse d'Orion que je presente à l'Academie a été tracé avec le plus de soin qui m'a été possible. La nebuleuse y est représentée telle que je l'ai vue plusieurs fois avec une excellente lunette achromatique de 3 pieds et demi de foyer, a triple objectif,

portant 40 lignes d'ouverture, et que grossissoit 68 fois. Cette lunette faite à Londres par DOLLOND, &c. . . " and the engraving is inscribed "Presentée au Roi le 27 Mars 1774." It has consequently all the authenticity which can be desired: and the habit of viewing such objects which its author had acquired in his very successful researches on nebulae, would seem to render it little probable that his eye would be deceived in such a point;—yet of the two it must be confessed that this part of LE GENTIL's approaches much the nearest to the present appearance, and there is even an approximation to the rectangular form still perceptible. This will serve to show how great the difficulty is of representing such objects, and with what caution evidence of changes in them ought to be received.

Regio Messieriana. Brachium Messieri seu Proboscis major. This arm was first seen, and is very imperfectly represented, by MESSIER; the fainter arm or proboscis has escaped his observation entirely, as also has the elongated nebula between the stars α and μ , which is of the last degree of faintness. In favourable moments it exhibits a suspicion of a star α in its middle.

Mairanni Nebula et Constellatio. The curious form of this nebula, which throws out a kind of projection or tail just reaching to a small star a , is not depicted by MESSIER, who indicates merely a faint round nebulousity encircling the star μ equally on all sides like an atmosphere. It consists of two principal parts; the body, which is the part formerly seen, and the tail, which extends between the stars a and e , leaving a pretty perceptible division or space of fainter light, as if it were about to break into two. The other small stars b , c , d , f , g , h , i , are unaffected by nebulousity; i is one of MESSIER's stars micrometrically laid down.

Regio Picardiana. Only the star ν is noticed by MESSIER. The very curious filaments which extend across or nearly across the great sinus are here noticed for the first time. They require distinctness as well as light. The small island *Nebula minima*, just at the entrance of the fauces, appears as if drawing together into a star. It is barely if quite detached from the point of the lower jaw, which is pretty bright and of a ragged appearance. The portion in which the stars ν , w , y are situated, is on the other hand darkish, and the nebula appears as if about to separate in this place, and leave the extremity of the lower jaw detached. Between δ and ϕ , close along the borders of the sinus at its bottom, is a part much brighter than the rest, of small breadth.

Regio Derhamiana, &c. From the trapezium there run out branches or tails

like those of comets, in the direction of the star τ , along the confines of this and the Huygenian region, and across all that space between τ and σ and ξ , which lose themselves imperceptibly in the very faint diluted nebosity which fills the *Fouchian* region and adheres more or less in the form of wisps to all the stars in the latter, especially the stars τ and ρ . The stars σ and ξ , on the contrary, are rather free of nebosity, being situated in a darker portion, which forms a natural separation between the *Fouchian* and *Godinian* region. In the latter the nebula dies away imperceptibly into total darkness.

I have thus described the chief points, to which the attention of some future inquirer may be advantageously directed in search of alterations. His observations ought of course to be made with an instrument as similar as possible to mine, or the comparison cannot be fair, nor the conclusions justified. I am far from supposing that all, or nearly all, the peculiarities presented by this singular object are embraced in my drawing: on the contrary, there can be no doubt that a telescope of greater power will exhibit many more of its phenomena, and possibly discover other branches, or exhibit nebulous atmospheres about other of the small stars near, not noticed by me. Whether it might not be practicable so far to re-accommodate the 40-feet reflector, (now almost decayed by age and unavoidable exposure to weather,) as to bring the advantage of its immense light to bear on this nebula, is a consideration which has often suggested itself to me; but the present notice will I hope at least be regarded as a sufficient addition to the actual state of our knowledge to merit the indulgence of the Society.

4. *Of the Nebula in the Girdle of Andromeda.*

This wonderful object, like that in Orion, has been imperfectly seen and contradictorily described by various astronomers. It has been known from the earlier ages of astronomy, at least as far back as 905 A.D. being very visible to the naked eye, but attracted little notice till the time of SIMON MARIUS, who re-discovered it in 1612. He describes it as presenting the appearance of a candle seen through horn; that is, a diluted light, increasing in density towards a centre. CASSINI in his *Elements of Astronomy* describes its figure as triangular; but LE GENTIL assures us that for many years he observed it round, and that it continued so till 1749, but that afterwards, in 1757, it was oval. "Je l'ai vu ronde comme je l'ai dit plus haut pendant plusieurs années, —je lui trouvai la même figure en 1749 lorsque je fis la decouverte de sa voisine.—Aujourd'hui elle est ovale, &c."

This history only shows how difficult it is to assign correctly the figure of an object which has no outline, but shades away insensibly on all sides. But the following distinct and positive observation of LE GENTIL deserves more particular notice. He declares its light to be perfectly uniform in all parts, and gives a figure of it so expressed. The following are his words, which would seem to admit of no mistake or qualification: "Elle jette de tous côtés des rayons de lumière; et elle est d'une égale densité dans toute son étendue; de sorte que je n'ai point remarqué que son centre fut plus clair ou plus transparent que le reste de son corps." The use here made of the word "transparent" is explained by a foregoing passage in which he speaks of "les endroits les plus blanchâtres et les plus transparens de la voie lactée." Again he says, "La description que SIMON MARIUS nous a laissée de la nebuleuse d'Andromède ne s'accorde guère avec mes remarques. Selon lui, les rayons de lumière que la composent, deviennent plus clairs, plus qu'on approche du centre. . . . Pour moi après l'avoir soigneusement examinée pendant plusieurs années, je l'ai toujours vue de la même densité dans toute son étendue."

This certainly appears very extraordinary: if true, it must be in a rapid state of condensation; for at present it has, not indeed a star, or any well defined disc in its centre, but the brightness, which increases by regular gradations from the circumference, suddenly acquires a great accession, so as to offer the appearance of a nipple as it were in the middle, of very small diameter (10 or 12"), but totally devoid of any distinct outline; so that it is impossible to say precisely where the nucleus ends and the nebula begins. Its nebulousity is of the most perfectly milky absolutely irresolvable kind, without the slightest tendency to that separation into flocculi above described in the nebula of Orion, nor is there any sort of appearance of the smallest star in the centre of the nipple. This nebula is oval, very bright, and of great magnitude, and altogether a most magnificent object.

I am inclined to think, however, that LE GENTIL's observation either cannot be relied on, or was not meant to be taken strictly. In the first place, MESSIER, who examined it in 1764 with LE GENTIL's description before him, says that, "Le milieu paraissait assez clair, sans aucune apparence d'étoiles,—la lumière alloit en diminuant jusqu'à s'éteindre:" and that he saw it well is clear, as he states the length of its major axis at 40'. But indeed a passage in LE GENTIL's own memoir, though not very intelligible in itself, will suffice to show that the ideas he attached to equality of density in all parts of a nebula are not the same as the phrase now conveys to us. I extract the passage

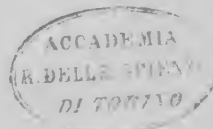
at length, on account of an elucidation it affords of the observations above recorded of a stellar appearance in the comet.

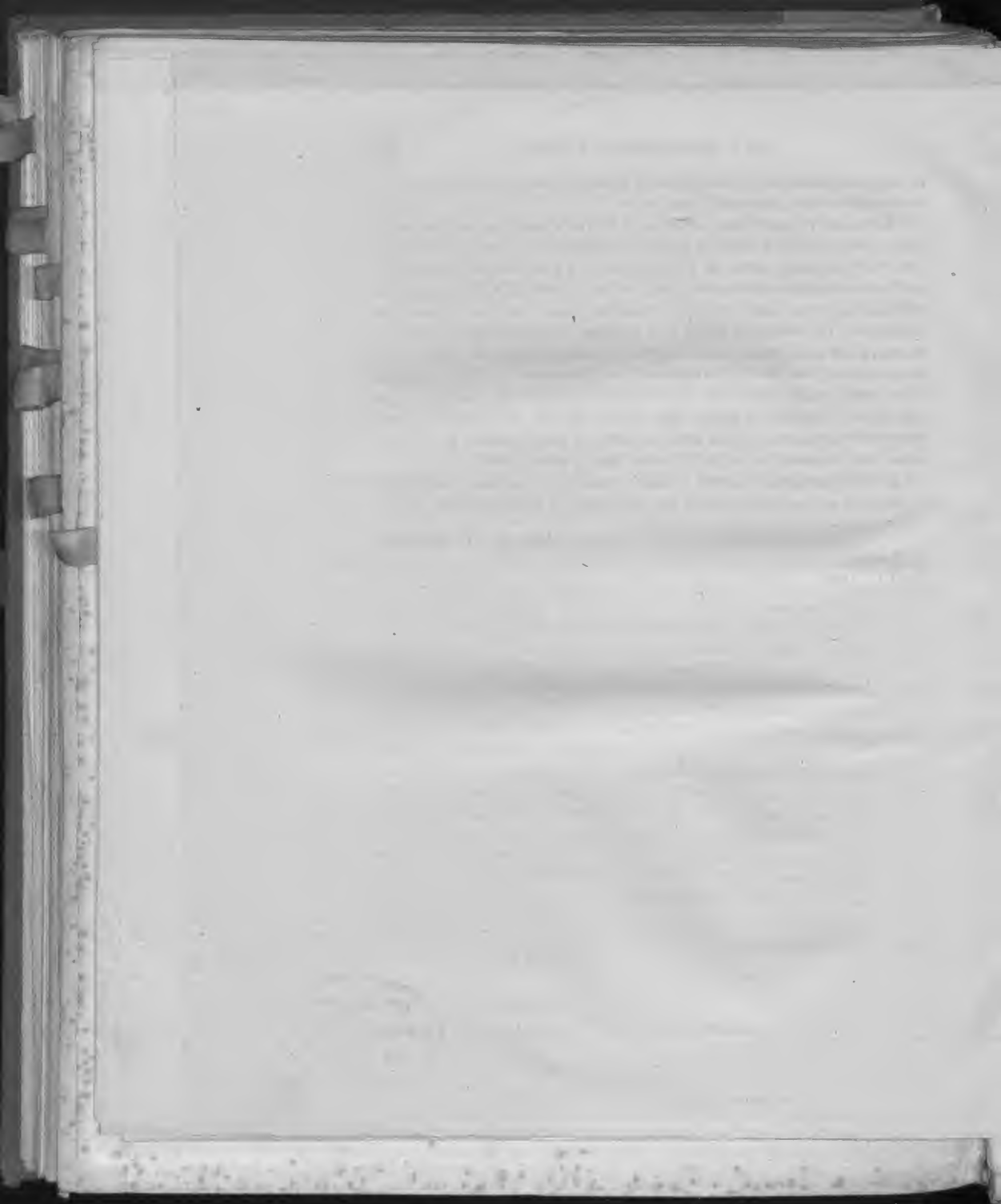
“Lorsqu’on regarde cette nebuleuse à la vue simple, on voit une petite nuage qu’on prendrait aisément pour une comète si on n’était pas au fait du ciel : en le regardant même un peu fixement, il y a de momens pendant lesquels on croit appercevoir vers le milieu une très petite étoile, ou du moins un espèce de noyau un peu plus clair et plus transparent que tout le reste de la nebuleuse. On remarque à peu près la même chose avec une lunette d’un ou deux pieds de longueur, mais lorsqu’on emploie une lunette de huit ou neuf pieds de foyer, c’est alors qu’on apperçoit une différence : *la nebuleuse paraît d’une égale densité* dans toute son étendue ; les rayons de lumière qu’elle jette de tous côtés vont se perdre dans le reste du ciel ; et comme ils ne sont composés en apparence que de *filets* très déliés et assez détachés les uns des autres, leur extrémité se confond aisément avec le reste du ciel.”

I give this passage as it stands, without pretending to explain or understand it, though it seems probable that a very bad telescope must have been used.

JOHN F. W. HERSCHEL.

London,
April 11, 1826.







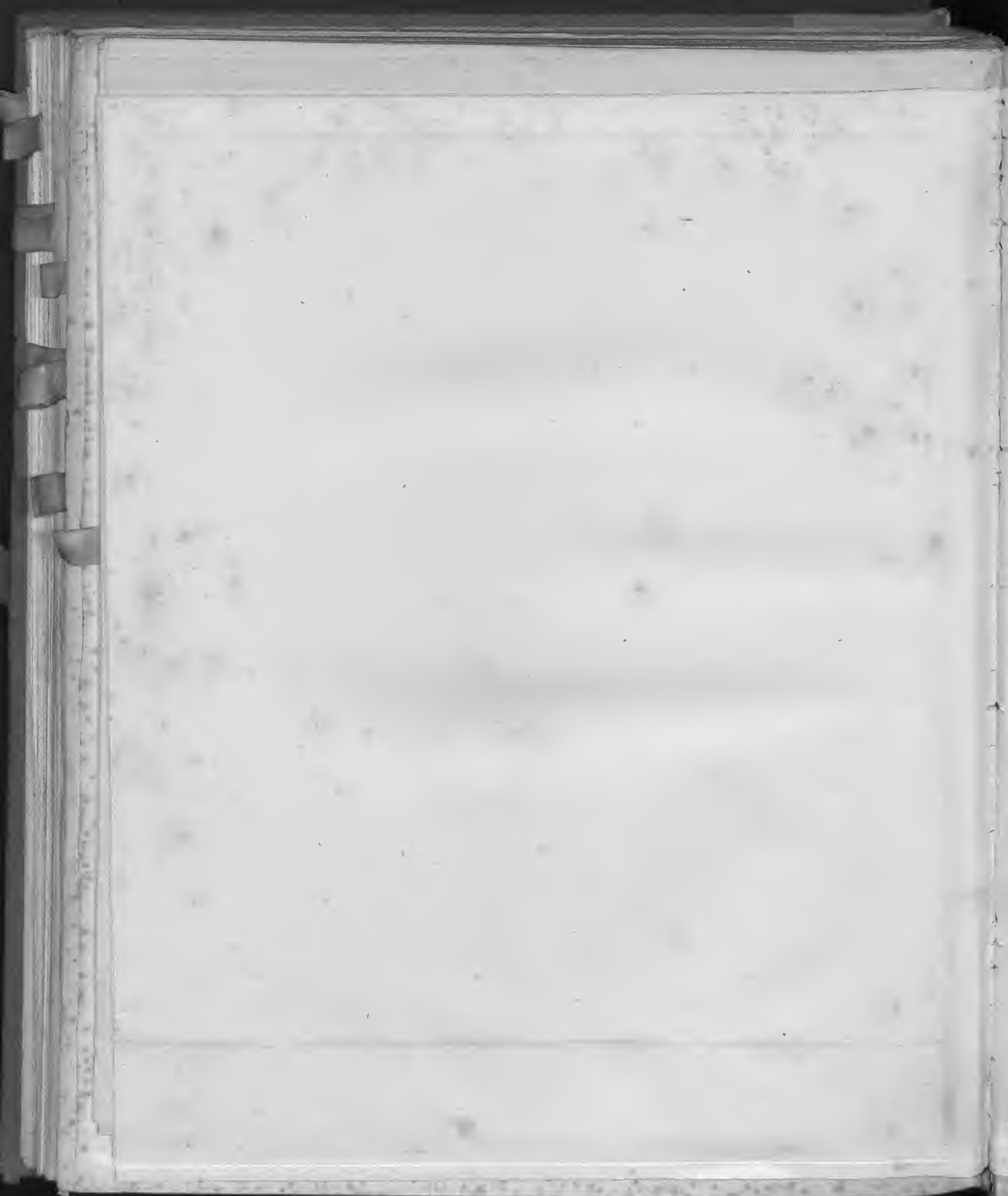




Approved for the Astronomical Society of London by James Dove

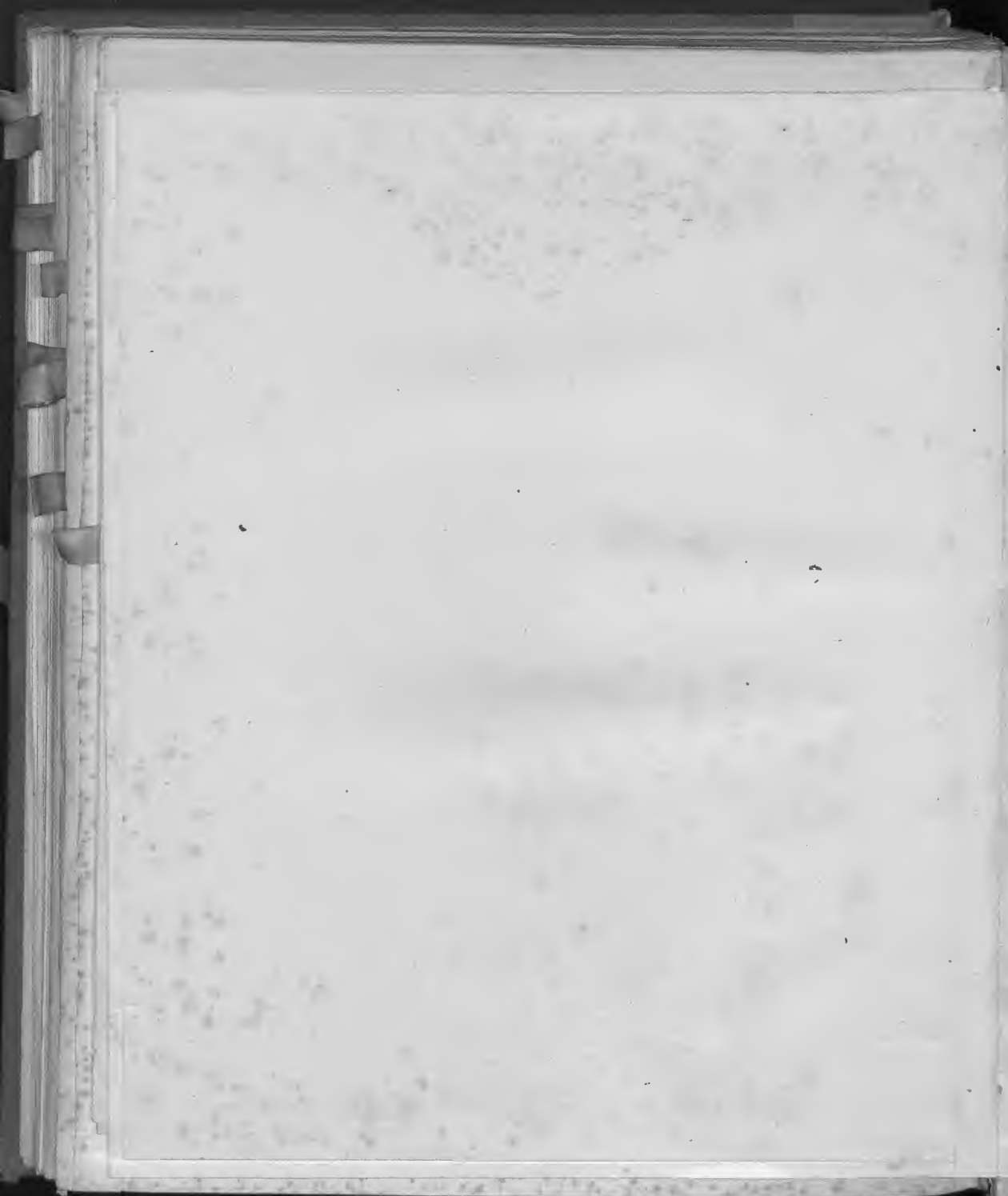
The 2nd Comet of 1825, as seen on the Night of the 7th Oct. 1825, with the 20th inch Reflector

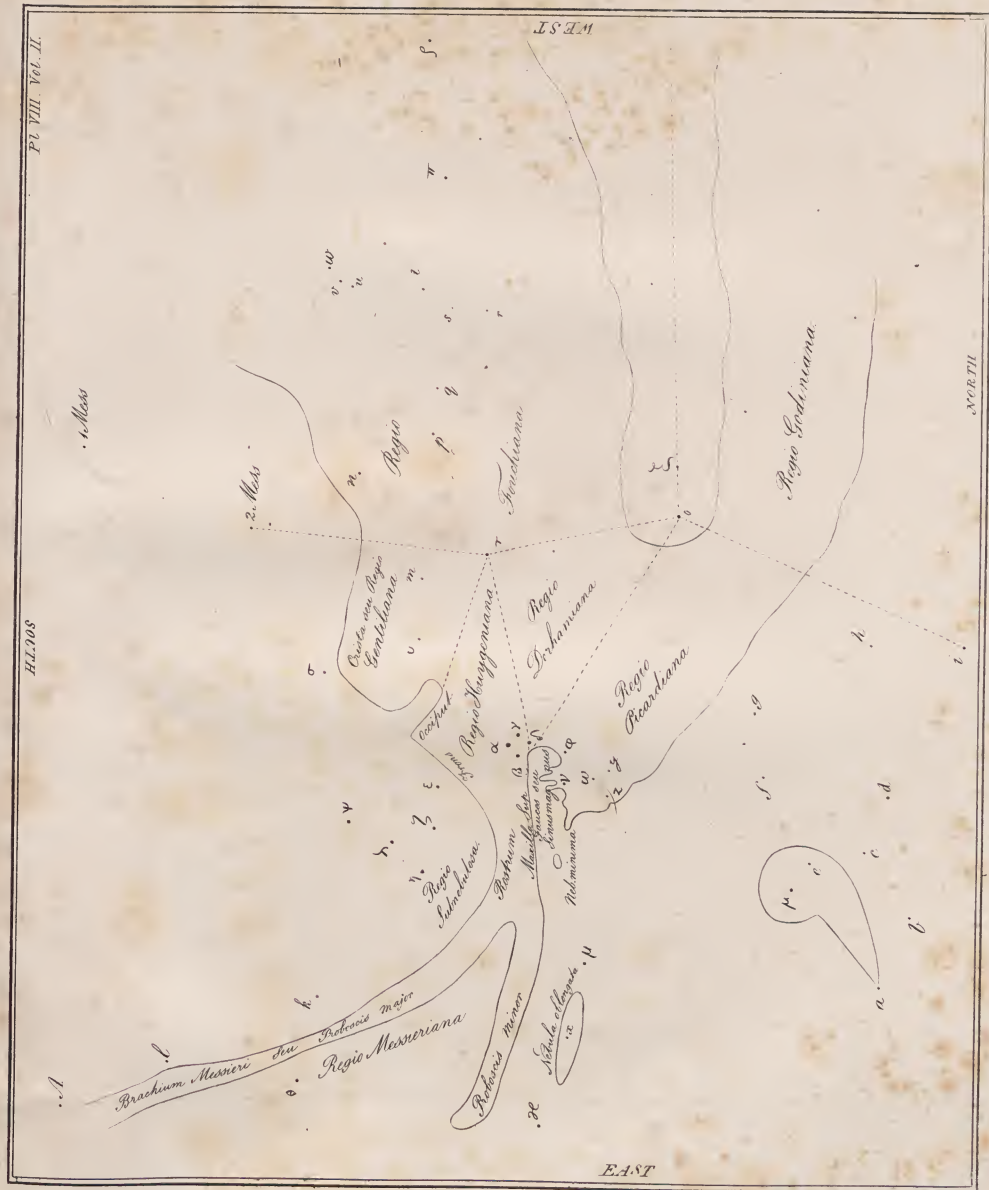
L. J. W. Herschel, del.



Engraved for the Anatomical Society of London by J. W. Bower

The Nuclei in the Small Vessels of Ovary as seen on the 17th July 1865, in the 20th day of the period. (Diameter .48 inches.)













e con-
est pla-
de la f-
comm-
que a-
er la p-
aloge

EN (1)
be, p
FATA
n. G
LATA
le la
LITZ
iques
DIE
H (A)
le 2
ACH
EMEN
X
du S
les, B
TEC
OUR
A LA
TEQU
1fr. 5
aux de
age, p
age,
ur de
den v
aux de
al, à
coure
aux v
à p
vérie
nimal
vérie
brié l
oule d
rentie
109, p

2XPS
 ISE (DO
 OUCHER
 INES (B
 AGRICOL
 BLITE
 S AUX
 ACTION
 GRICOL
 TRAN
 EUR
 ETED
 AREH
 EY OF
 BE JOI
 PLES, 2
 ECTEAL
 S OF
 CIVIL
 RUM
 2/6/11
 TAW
 TET
 OF (C
 arligan
 ON DES
 OF 1

advertisements